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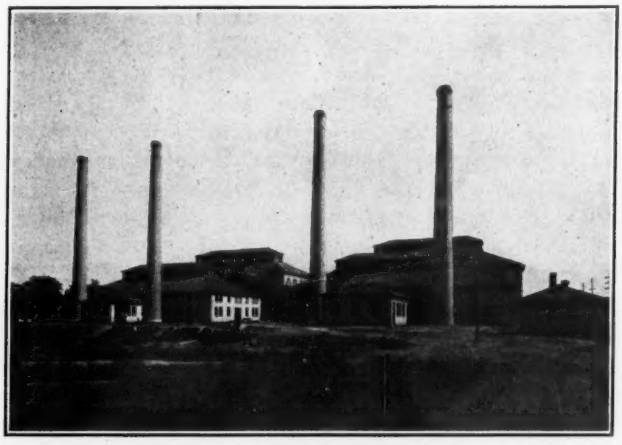
A $3,000,000 FILTERED WATER PUMPING STATION

240,000,000 Gallon, High-Duty Pumping Plant at Lardner's Point, Philadelphia

When the City of Philadelphia, which for many years has been troubled with an impure water supply, decided about seven years ago that it would filter all the water that passed into its water mains, it tackled a job of immense proportions, not only on account of the quality of the water which must be filtered,



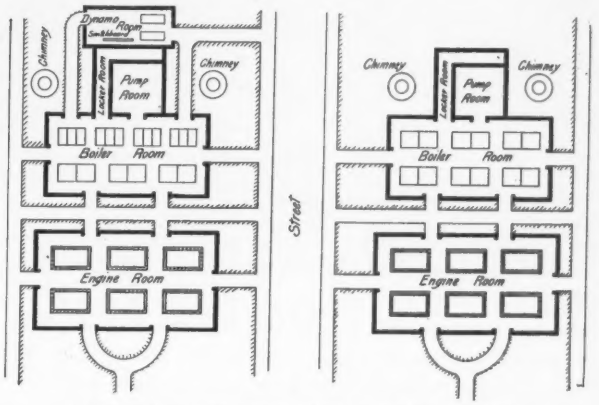
Exterior of the Lardner's Point Pumping Station

but on account of the lavish use of water to which its inhabitants are accustomed. Compared with New York which uses 120 gallons per day per person, Boston, which uses 143 gallons, St. Louis which uses 159 gallons, and Chicago which uses 190 gallons, Philadelphia uses 230 gallons per person per day and to give each of its 1,500,000 inhabitants a liberal supply of water requires the handling at the present time of 345,000,000 gallons per day. Already about $25,000,000 have been spent on the construction of filter beds, pumping machines, conduits and a considerable number of more millions will be required before the entire filtration system, which has been building for a half dozen years, will be completed.

The Schuylkill and Delaware rivers, from which Philadelphia draws its water supply, are lined with thriving manufacturing towns and the water is so contaminated by these towns that by the time it reaches Philadelphia, it becomes dangerous to use it as a drinking fluid. Before the adoption of the filtration system, the Schuylkill river was the main source of water supply for the city, but as the Delaware river is very much larger it was decided, since all the water was to be filtered, to erect the largest filter beds along its shore at Torresdale about 15 miles from the center of the city.

The filtration system, as laid out at the present time, consists of three filtering beds, located in widely separated parts of the city. The Roxborough filters, which are located at the northwestern part of the city near the Schuylkill river, will supply the suburbs of Germantown, Mt. Airy and Chestnut Hill. The Belmont filters, which are located in the western part of the city, will supply that portion of the city which lies west of the Schuylkill river known as West Philadelphia.

By far the largest filter beds of the system are located at Torresdale on the west bank of the Delaware river and they will supply the district comprising the northwest, central and southern portions of the city which includes at the present time



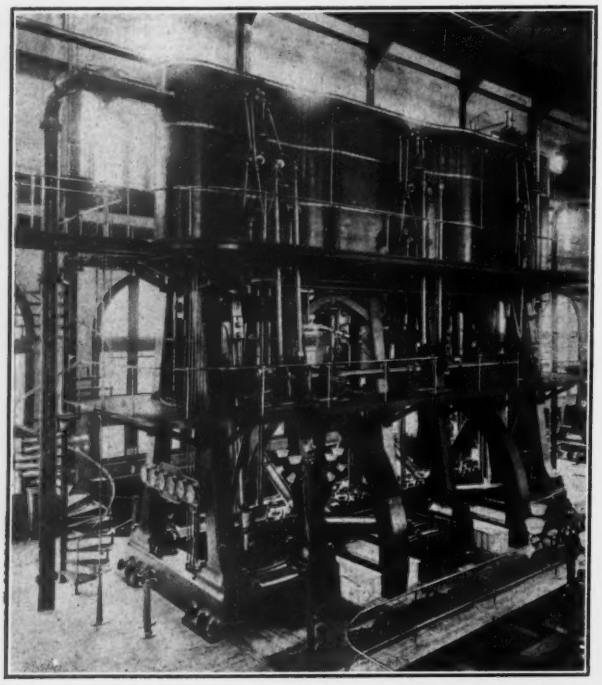
Plan of the Lardner's Point Pumping Station

a population of 1,100,000. The total capacity of the Torresdale filters based on sixty-five filters which are installed, will be 248,000,000 gallons in twenty-four hours.

The general method of filtration used at Torresdale is to pump the water from the river by means of a low duty centrifugal pumping station into the sand filters which cover an area of about 50 acres, the clear water flowing to a clear water

basin having a capacity of 50,000,000 gallons. From the clear water basin at Torresdale, the filtered water flows by gravity through a large conduit of horseshoe section, equal in area to a circle 10 feet in diameter, to the Lardner's Point pumping station at Tacony, Pa., a distance of 14,035 feet or about 2.8 miles. The capacity of the conduit is about 350,000,000 gallons daily.

The Lardner's Point pumping station, from a stationary engineer's point of view, is the most interesting part of the whole filtration system as it must handle all the filtered water that is supplied to 1,100,000 inhabitants and in size it ranks as the largest individul high-duty pumping station in this country. The total money value represented by this plant lies between $3,000,000 and $4,000,000.



One of the 20,000,000 Gallon Holly Pumping Engines

The distinctive feature of this pumping station is the fact that it is laid out as two distinct separate stations which have no connection whatever with each other. The two boiler rooms and engine rooms are entirely separate; in fact the plant consists of four separate buildings, two being used for boiler rooms and two being used for engine rooms, one boiler room being connected to the opposite engine room by means of underground steam pipes. All the buildings are built on a pretentious architectural scheme and they resemble the buildings of the public library more than they do a power station, but they are admirably designed for the purpose for which they are used. Each boiler room is 80 feet wide by 170 feet long and each engine room is 87 feet wide by 170 feet long. The boiler rooms are built of yellow brick while the engine rooms are built of yellow brick with granite base and trimmings. Each boiler room has two large brick stacks 150 feet high and 15 feet diameter, at the base.

At the present time, only one set of buildings are equipped with machinery; but as they are practically to be duplicates of each other, the description of one complete, half of the plant, will describe the machinery in both. The boiler room contains six 500 horse-power Edgemoor water tube boilers, arranged in batteries of two each, and twelve 200 horse-power I. P. Morris tubular boilers arranged in batteries of three each. The water-

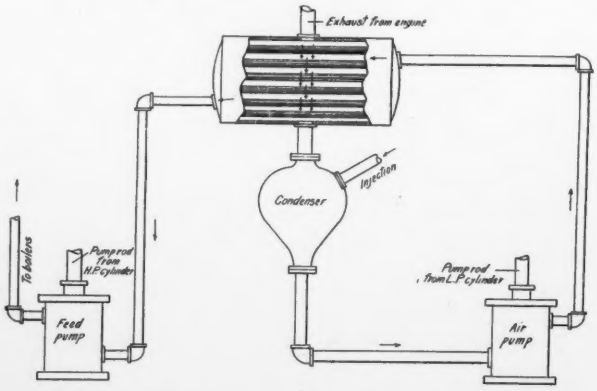
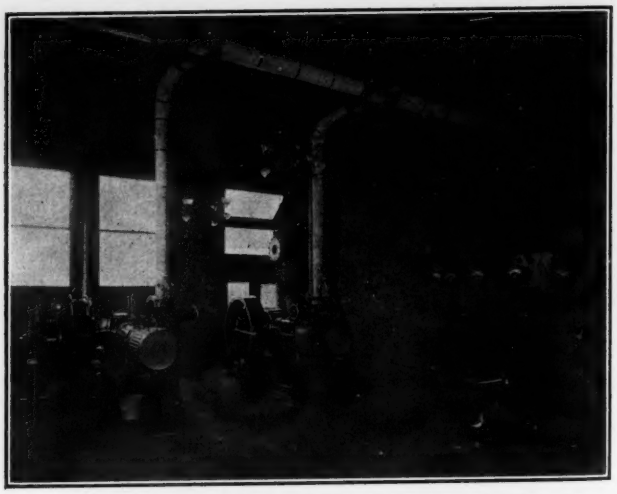


Diagram of Condenser and Feed Pump Arrangement

tube boilers are equipped with Wetzel mechanical stokers while the tubular boilers are hand fired. Each pair of mechanical stokers is run by a 5"x5" American blower engine.

The bituminous coal which is used for fuel is brought to the station by barge and at the present time is handled by hand and hauled a considerable distance to the storage yard near the boiler room. From the yard the coal is shovelled on hand cars which are wheeled by hand to any position of the boiler room. The center of the boiler room is arranged with two lines of tracks and a number of switches, so that any combination or arrangement of cars can be had. The ashes from the boilers having the mechanical stokers, drop to the ash-pit below the boiler room floor where they are dumped into hand cars and run along the ash pit under the boilers to the end of the boiler



Dynamo Room Equipped with 50 K. W. Units

room. They are dumped into an ash pit and are lifted by means of a bucket conveyor driven by a 7½ horse-power motor into carts which haul them away. The ashes from the tubular boilers are pulled and handled by hand.

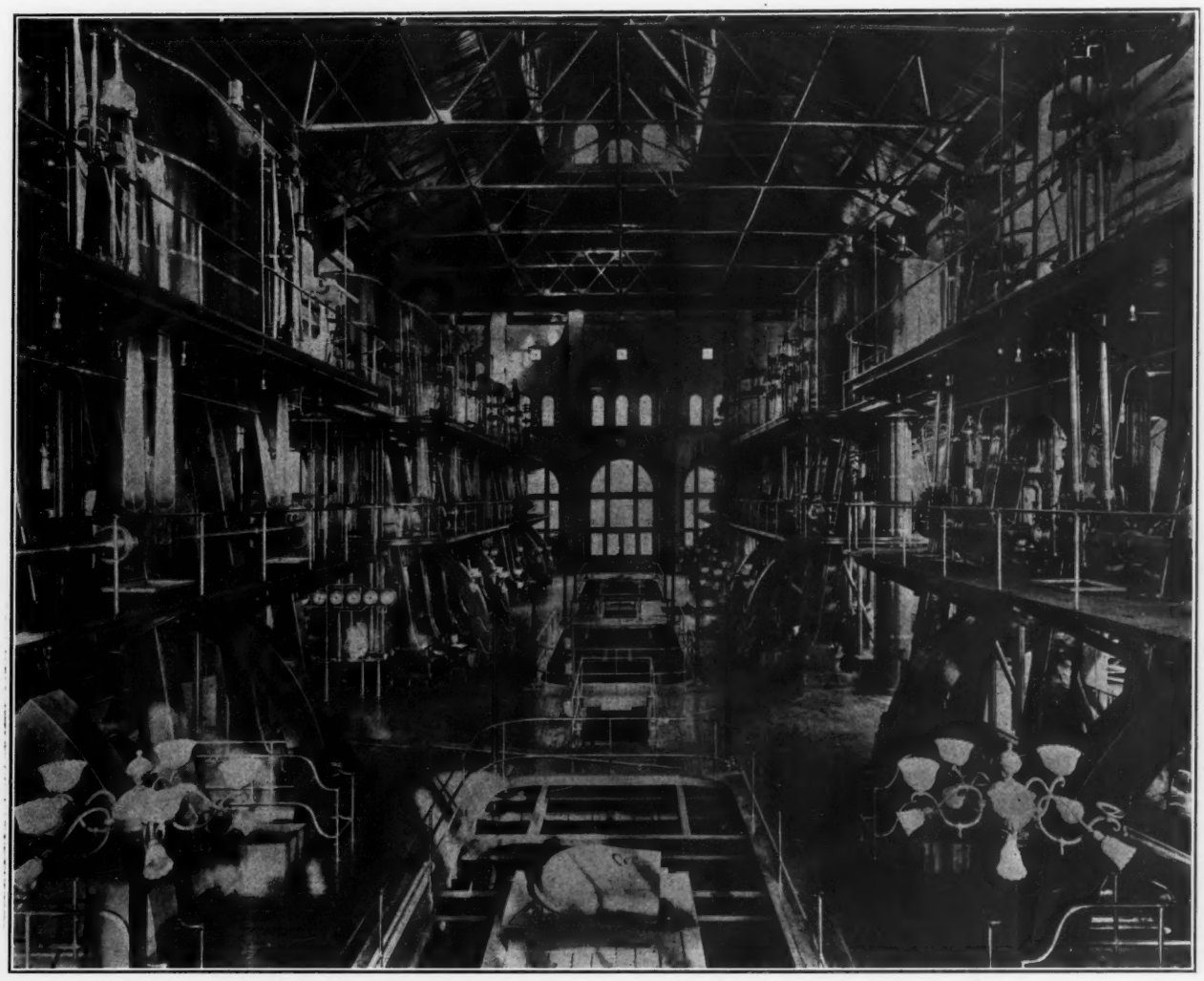
The tubular boilers are of the internally fired type, each hav-

ing two furnaces 4 feet in diameter and 7½ feet long. The boilers have a diameter of 9 feet and a length of 20 feet. the grate surface for each boiler being 40 square feet. The Edgemoor boilers are of the sectional type and are equipped with a rolling steel door which makes up the boiler front. Each boiler is equipped with two American safety valves, Liberty blow-off valves, and Reliance water columns.

Steam from the boilers at 150 pounds pressure goes to an 8-inch header which is enlarged to a 14-inch header in the center of the boiler room. From the 14-inch header two branch 14-inch mains are carried underground in conduits to the engine heating the boiler feed are 8 feet long and 3 feet in diameter and are equipped with 150 tinned and annealed brass tubes, No. 16 B. W. G. The jet condensers, which can be operated by force or suction injection, are 5½ feet high and contain 8" spray nozzles. Raw water in connection with the suction injection is generally used in the condensers, but force injection with the filtered water is available.

The air pump is connected to the low pressure cross-head by a steel arm, the diameter of the piston being 28 inches, stroke 66 inches.

The boiler feed pump on each pumping engine is driven



Interior of the Engine Room, Lardner's Point Pumping Station, Philadelphia

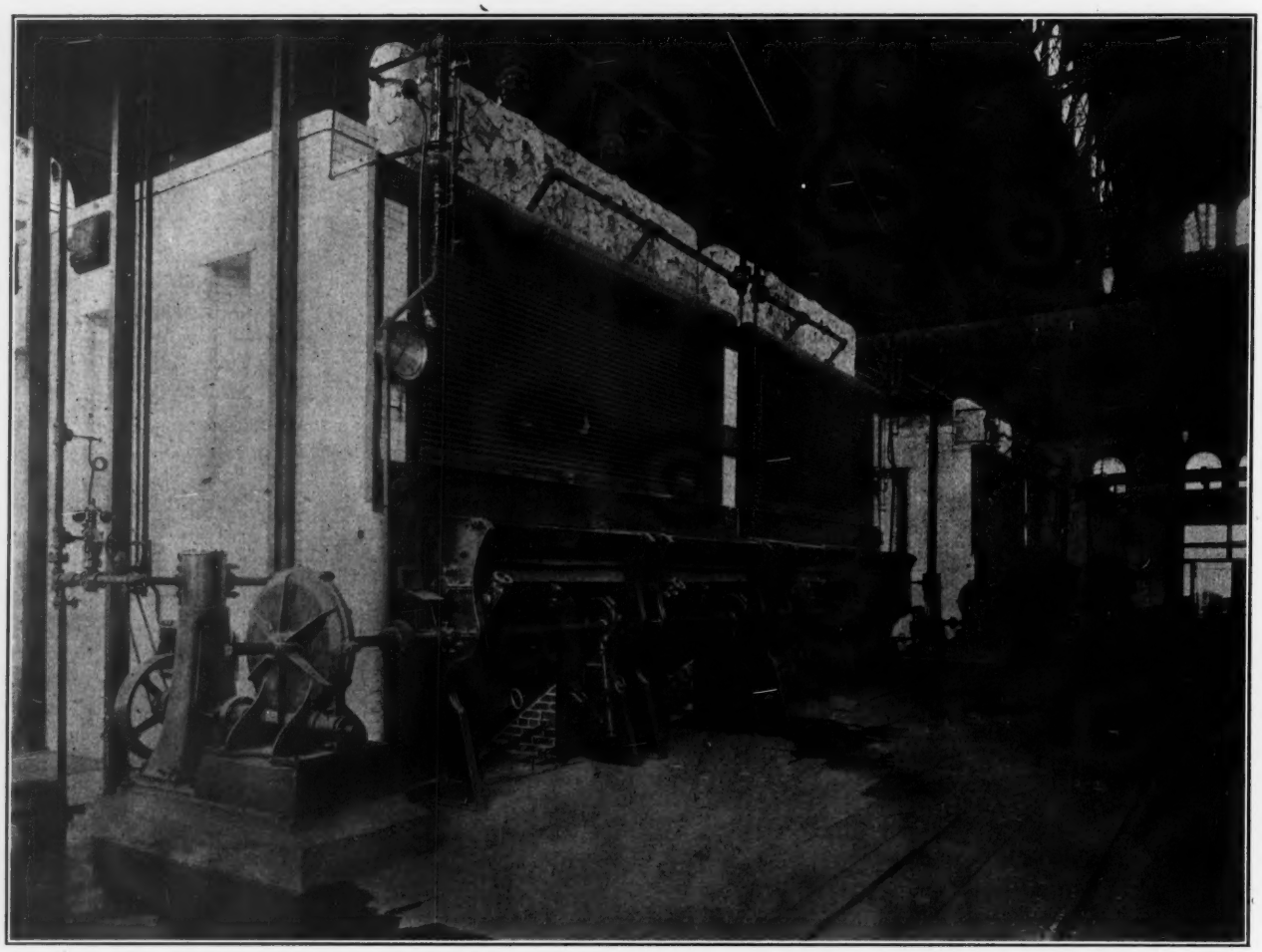
room. The feed water is supplied from the condensers of the engines which are each equipped with a complete condensing air pump and reheating apparatus, the temperature of the feed water as it enters the boilers being about 96 degrees. The arrangement of heater, condenser and air pump connected to each pumping engine is shown in the sketch. The exhaust steam from the low pressure cylinder of the pumps passes around the tubes of the heater before it enters the jet condenser. The air pump then pumps the water through the tubes of the heater on its way to the boiler. The heaters used for from the high pressure plunger cross-head. It is an outside packed plunger pump with plunger 3¼" diameter and 66" stroke. If all the water is not required by the boilers, a pressure valve which is set at 175 pounds or 25 pounds above the boiler pressure, opens and the surplus water flows to the hot well. Should, however, the water furnished by the pumping engines not be sufficient for the boilers or should the engines be shut down, there are available six 5¼"x3½"x5" Snow boiler feed pumps which are available as a boiler feed reserve and are located in the pump room next to the engine room.

The engine room contains six 20,000,000 gallon, Holly high duty pumping engines. The engines are of the vertical crank and fly-wheel triple expansion type, with a single acting water plunger and duplex suction and discharge water chambers. Each engine weighs about 1000 tons and is mounted on a concrete foundation weighing 800 tons. Each engine is 57′ 7″ high, the foundation being 20 feet below engine room floor and the tops of the steam cylinder 37′ 7″ above engine room floor. Each engine is 20 feet wide by 35′ 10″ long and the foundation on which it stands is 39′ long, 22′ wide and 10′ deep.

The diameters of the steam cylinders are 32″, 60″ and 90″ in diameter with a 66″ stroke, the three water plungers being 33″ diameter and 66″ stroke. The cylinder heads and cylinder loop. The steam enters the high pressure cylinder and after being used in that cylinder it passes into the first receiver, then into the intermediate cylinder and second receiver and thence to the low pressure cylinder and condenser attached to the pumping engine.

The first and second receivers are equipped with reheating coils. The first receiver contains 40 coils of 1¼″ copper tubing giving a heating surface of 166 square feet, while the second receiver contains two nests of 50 coils of 1¼″ copper containing 304 square feet of heating surface.

The steam valves are of the Corliss pattern, the valves on the low pressure cylinder being operated by compressed air. The crossheads are of cast steel, having a forged steel pin 12″ diam-



Interior of Boiler Room showing Six 500 H. P. Edgemoor Boilers equipped with Wetzel Mechanical Stokers

are steam jacketed and the receivers are equipped with reheaters. The speed of the engines is 20 revolutions per minute and the water is forced into the city mains at a pressure of about 108 pounds per square inch.

The steam from the boiler room is brought underground to the engine room with two 14-inch mains which connect to the steam main under the engine room floor. Before passing into the 14-inch main the steam passes through two separators after which is led around the room in the form of a loop. The steam main is 14 inches in diameter between the two steam feeders but is reduced to 12 inches in the other portions of the

eter, 11″ long. The crank pins are of forged steel, 12″ diameter, 11″ long, and are forced on the shaft with 200 pounds hydraulic pressure. Each engine is equipped with two flywheels each being 20′ diameter, 14″ face, weighing 60,000 pounds.

The pump pistons are driven direct from the engine crosshead by means of four 5″ round rods. The plungers are 33″ diameter, made of cast-iron, turned and ground. The discharge and suction openings of each cylinder is 42″ diameter. Each water chamber is provided with six suction decks and six discharge decks which are made of cast steel and are removable. Each deck contains 72 valves 4 3-16″ diameter.

Each engine is equipped with five Aschroft gauges and one revolution counter. The gauges record the steam pressure, pressures in the receivers, vacuum and water pressure. The average steam pressure is 150 pounds, the average first receiver pressure 35 pounds, the average second receiver pressure 5 pounds, the average vacuum 27.5 inches, the average water pressure about 108 pounds and the average number of revolutions, 20.

The dynamo room is situated on the opposite side of the boiler room from the engine room. It contains two 10"x12" McEwen engines direct-connected, two 50-kilowatt Thompson-Ryan dynamos. The output from these dynamos is used for lighting the buildings and for the motors driving the 30-ton Niles cranes over the engine rooms, and for the ash hoists. These dynamos run at 250 revolutions and supply direct current at 250 volts. The exhaust from these engines passes through a Wainwright heater which is used for heating the feed water supplied to the boilers by the make-up pumps.

The switchboard is composed of four panels of grey marble and is equipped with a Weston voltmeter, two ammeters, and the usual knife switches, fuses and circuit breakers.

The tests, which have been made on the pumping engines, show that under a head of 227 feet and a steam pressure of 147 pounds, the total horse-power developed by the engines was 920 H. P., the mechanical efficiency was 96.8 per cent. and the duty was 141,251,000 foot-pounds.

The Lardner Point pumping plant is under the direct supervision of the Bureau of Water of the City of Philadelphia, the engineers of which designed the entire filtration plant and pumping stations. Fred. C. Dunlap is Chief of the Bureau of Water and Harry M. Hillegass is Chief Engineer of this $3,000,000 pumping plant.

PULLEYS AND THEIR USE

The Advantages and Disadvantages of Solid and Split Rim Pulleys

By E. H. Naylor.

There are numerous makes of iron, pressed steel and wooden pulleys on the market at the present time, which gives the engineer an endless variety to select from to meet almost any condition. They all have their advantages and disadvantages which is the reason why good judgment must be used to select the proper pulley to meet a given condition; in some cases the iron pulley may be just what is needed, and in other cases the wood split-rim pulley will do just as well and give perhaps better results.

The improvements made by the introduction of the split-rim and hub pulley, has been a wonderful one and has come as a blessing to the engineer and millwright. The old cast iron, solid rim pulley, it is to be hoped, will be a thing of the past in line shafting, so far as it is practical. When nothing but solid rim, cast iron pulleys were in existence, the engineers and millwrights had their troubles, as it required considerable time to make a change in pulleys, or when one had to be taken off or put on. As a rule, this always required the taking down of a hanger or two, separating or uncoupling the shaft and possibly moving ten or a dozen pulleys before the new pulley could be placed. If any one has been unfortunate enough to have had this experience, they will doubtless remember how stubbornly some of those pulleys on the shaft refused to be shifted, and it often required more labor to take off one of those solid rim pulleys than it does to place a dozen split-rim pulleys at the present time. Since the split-rim pulley has been manufactured, it has reduced the hours of labor of those who have the care of them, and it has not meant night and Sunday work, as was formerly the case with those who had this work to attend to in factories.

One make of pressed steel pulleys that has been recently placed on the market is shown in Fig. 1. It is of the split-rim type and is made with interchangeable bushings which makes it possible to use the same pulley on different size shafting, by simply substituting a bushing with bore the size of the shaft and which may be kept in stock for such changes.

While the pressed steel pulley is meeting the many requirements that is desired, such as lightness and low wind resistance, still it cannot be considered a success above 24" diameter for the reason that it will not stand the severe strains and run true after being used some time. The construction is too light and it will show signs of weakness by a slight untrueness which will be very noticeable. This is one of the things that must be corrected in the pressed steel, split-rim pulley before it is a complete success and while it has all the other good features so much desired of pulleys, it is built entirely too light for general use.

The two points which are in its favor, and which should be taken into consideration by all, are lightness and low wind resistance. If any one in charge of a large factory does not look to these two points, much more power than necessary will be used and friction will be increased. If the pressed steel pulleys were built of heavier stock in sizes above 24 inches, they would be all that could be desired.

The trouble with wood pulleys, that is generally complained of, is the slipping on the shaft and the high wind resistance due to the bulky design of the spokes. These two points are certainly disadvantageous and are to be considered when selecting wooden pulleys. While wooden pulleys have done remarkably good service in lots of cases, there is one particular type which gives less trouble than any of the other makes, and if properly placed will do more work without showing any signs of distress. This type is shown in Fig. 3. The bushings of this pulley, the same as those used with the pressed steel rim pulley, are interchangeable for shafts of different diameters, but they are made eccentric, as shown in Fig. 2. This kind of bushing cannot be used on the ordinary makes of wood pulleys as

the bore of the pulleys must be made to fit the bushing. This style of pulley gives less trouble than any other type of wooden pulley in regard to slipping on the shaft.

It is rather amusing to see some men put a pulley of this type on the shaft for the first time. They invariably get the eccentric bushing wrong and bless the man who designed the pulley for making such a fit. They try to build it up with cardboard, leather, sand-paper or some other stuff and finally give it up in disgust. When shown the principle of the bushing and the proper method of putting them on, these men are as a rule strongly in favor of this type of pulley.

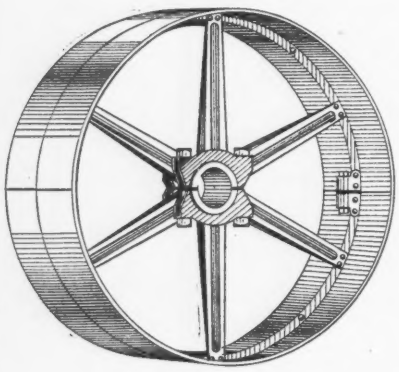


Fig. 1

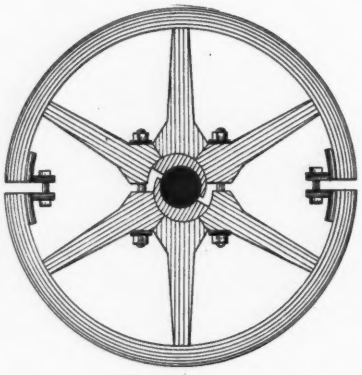


Fig. 2

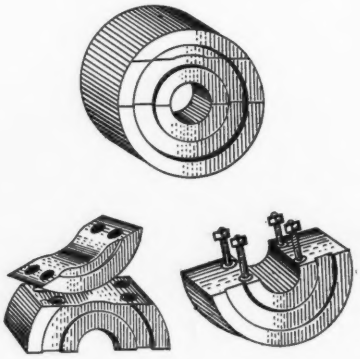


Fig. 3

The bushings are made as shown in Fig. 2. To be properly set ready to be tightened up, the thick side of the bushing is driven away from the center line of the pulley which causes the two halves of the pulley to be thrown farther apart, both at hub and at the rim. This should be about from ¼ to 5-16" and can be gauged by setting nuts on the bolts so that when they are driven to spread that distance, the pulley will have a firm grip on the shaft; then draw up on the bolts evenly until the rim comes together. If these pulleys are treated in this manner they will rarely give any trouble unless considerable overload is thrown on them. The manufacturers of this type of pulley were compelled to discontinue making it for a while owing to the trouble in getting the users to understand it, but the demand became so great by those who understood its use that they were compelled to resume its manufacture again.

The split-rim and split-hub cast iron pulley deserves mention as it has a number of good points in its favor and is as good as any split-rim pulley where the shafting is generally of uniform size. This pulley has the same disadvantage as a solid rim cast iron pulley because it has no interchangeable bushing; otherwise it has been of as much value as any of the other split-rim pulleys and has as low a wind resistance as the pressed steel pulley.

In small sizes up to 8" and 10", the solid split wood pulley, shown in Fig. 3, has given very good results and is much easier placed than those made with spokes because it is more difficult to get a wrench on the nuts to set them up.

If loose pulleys are made of the solid cast iron type, they give trouble, as a rule, if not cared for properly. If all loose pulleys were designed so that they could be packed with a good supply of good grease, there would be very little trouble from them, but where they have a small hole that runs from the rim of the hub to the shaft, they do not have supply enough to draw from when it is needed badly, or when it has been forgotten. I have found that loose pulleys with packed hubs have run far superior to those of other design.

In conclusion, I have found that it pays to investigate the different makes of pulleys, as considerable time and money can be saved by a few minutes thought on the subject.

Record-Breaking Year of Coal Production.

A record-breaking production of between 450,000,000 and 460,000,000 short tons of coal in the United States is indicated by returns compiled thus far by the United States Geological Survey. This is an increase of about 10 per cent. over the record-breaking output of 1906. The most notable increase was made in the production of Pennsylvania anthracite, in which a gain of over 20 per cent. is recorded. This increase has been due to the increased use of hard coal for domestic purposes, as anthracite to a large extent has been eliminated from industrial uses. About 76,366,000 long tons of anthracite were mined in 1907 compared with 55,696,000 long tons in 1906. The increase in the bituminous coal production is about from 7 to 10 per cent., and had it not been for the industrial depression during the last three months of the year, it is almost certain that the increase would have amounted to 15 per cent. As it is, the output is about 375,000,000 tons.

Buying Coal by the Heat Unit.

The coal purchased by the United States Government amounts to nearly $6,300,000 in value, the price paid per ton being based on its heating value. From time to time, as the dealers are delivering coal, samples of the coal are taken to the laboratory and analyzed to determine their heating value and their content of fixed carbon, volatile matter, ash, and sulphur. If the coal falls much below the standard set in the contract, a penalty is imposed; if it proves to be of higher grade the dealer gets a premium. A number of premiums have been paid by the Government, and an absolute economy over the old haphazard methods of purchase has been proved.

THE PRINCIPLES OF MECHANICAL REFRIGERATION

An Unusually Clear Explanation of the Methods of Extracting Heat

By Jos. H. Hart.

Mechanical refrigeration is daily becoming a more general process, and the number of plants in active operation in the United States and elsewhere is steadily increasing. Their range of application is large, and also extending, and each of these applications often require different conditions for the best maintenance of the refrigeration, and it is unfortunate that more stationary and operating engineers are not familiar with refrigerating work in general. The theory back of the operation of these machines is extremely simple, and is no more difficult than the ordinary steam theory. It utilizes the same fundamental principles as are inherent in steam design, and similar conditions hold in nearly every case with slight changes only in their relationship and value. The following article is an attempt to explain the fundamental principles back of the ordinary refrigerating machine, in such a manner that it is understandable by the average man more or less familiar with steam engineering and its practice. The chief difficulty in an attempt of this kind is due to the fact that mechanical refrigeration employs several different principles in its production in as many different processes, and that these are more or less scattered throughout many of the applications, although many of them are localized to a greater or less extent for their application in a few industries. Thus mechanical refrigeration is produced to-day by three different processes.

First, the cooling which results when a gas is made to do work in a cylinder. If the gas is not hot at the beginning and expands and does sufficient work, it cools off enough in the process to produce refrigeration. This is the principle back of two types, the Bell-Coleman Atmospheric Air machine and the Allen Dense Air machine. These two types are extremely common on shipboard, although in not very large units. Other more efficient types are used on ships employed in the fruit and meat trade, and this type finds its best development on small steam yachts and vessels of a similar character. It is extremely uncommon on land, and its only advantage is its utilization of air, a working substance easily available under all conditions and one non-injurious.

The second type consists of the liquefiable gas machine, and this is the basis of the great majority of mechanical refrigerating machines in active operation to-day. The third type consists of a branch of this latter known as the vacuum process, in which the fact that the gas is liquefiable is of minor importance and its liquefaction is unnecessary. Here ice or refrigeration is produced by the evaporation of water by means of exhaust pumps, and the forced evaporation produces cooling on exactly the same principle by which it is produced in the ordinary liquefiable gas type. This machine, however, has only three plants in active operation in the United States to-day, and is extremely inefficient. It produces what is known as white ice, and to the author's knowledge, is used only in ice production in these three isolated plants of comparatively small capacity. Thus of all refrigerating machines in any department to-day, 98 per cent. consist of the liquefiable gas type, and hence in a discussion of the principles of mechanical refrigeration for the understanding of the average engineer this 2 per cent, can be neglected as an exception to the general rule and unnecessary for development.

Of the liquefiable gas types, there are two distinct gases utilized to-day, which are more or less common. These are used in the ammonia machine and the carbon dioxide machine respectively. Of all of this class over 90 per cent. consist of the ammonia type, and of the remainder 9 per cent. carbon dioxide, and the remainder some other gas. The ammonia machine is the only one worthy of serious consideration by the engineer of to-day, and if this is understood the principles of the other types and their behavior under working conditions becomes at once self-evident. Thus the problem results in an explanation only of the ammonia type.

The question which first arises in the mind of the average engineer is, how does ammonia produce refrigeration? It is somewhat similar to the question, how does a dynamo produce electricity? and is seldom, if ever, answered in a manner to make the subject clearly understood. The best answer to this question can be obtained by the elimination of ammonia itself as a working substance, and the conditions as operative in steam engineering are then almost identical. A thorough study of the heat conditions existent in the production of steam and the relations between this heat and the pressure, volume and other properties of the steam itself will make the phenomenon of refrigeration at once self-evident. Thus, steam is produced by the heating of water. Heat is measured in units called British Themal Units, one of these being the heat required to heat a pound of water 1 degree Fahrenheit. Thus if we take a pound of water at 32 degrees Fahrenheit, it requires 190 B. T. U. to heat it to the boiling point. It then requires 966 B. T. U. to change it to steam without raising its temperature. A further addition of heat to this steam results in what is known as superheated steam. These figures, viz: the temperature of the boiling point—212—and the latent heat of steam so-called, viz.: 966 B. T. U., are dependent upon the value of the pressure of the steam above the water. Thus, if the steam is confined and the pressure rises, the water will not boil until a higher temperature is attained. It then boils and requires less heat to change it into steam. Thus if water is confined in a boiler and heated, the pressure will rise and the temperature also, and at considerably less than 1,000 degrees, or at a point never attained in practice, the water will become so hot before it changes to steam that it requires comparatively no additional heat—practically less than 1 B. T. U. per pound—

to change it to steam. Conversely if the pressure is reduced by means of an exhaust pump over the water, the boiling point becomes less and the quantity of heat required to change the water at this boiling point to steam becomes greater. This is self-evident in actual practice under many conditions. In mountainous countries the barometric fall, or reduction in atmospheric pressure, is such, that at high altitudes the water boils at a sufficiently low temperature to permit the insertion of the hand without scalding. It is impossible to cook ordinary things, such as coffee or eggs, without long continued heating, even extending over several hours, and small boilers, with suitable safety valves, are used for cooking, in order to raise the pressure to the normal atmospheric pressure of 15 pounds and the conseqeunt boiling point to 212° F.

Thus the boiling point and quantity of heat in water required to evaporate it is a function of the pressure alone. It is possible to lower the pressure over water to such an extent that the boiling point of the water falls below that of the surrounding bodies, and we have the anomalous condition that in this condition—that is, practically in a vacuum—the water boils spontaneously at a temperature below the room and receives its heat from surrounding bodies in precisely the way the water in a boiler receives heat from the furnace. If this heat is withheld by means of insulated wrappers, the water which evaporates will abstract the heat from the remainder as long as it is hotter than the boiling point of the water at this pressure. It is possible to lower the boiling point of water by means of reduction of the atmospheric pressure above it with vacuum pumps to such an extent that it is below 32° F. and under these conditions the water boils and abstracts heat from itself until it becomes ice. This is the principle back of the vacuum ice process previously mentioned, but is not of much signficance in actual practice owing to the extremely inefficient operation of the vacuum pumps and the extremely high vacuum required for this development.

However, evaporation produced in any manner in water will produce cooling, owing to the fact that the change from water to vapor absorbs heat. The production of vapor, of course, is best accomplished by the utilization of a vacuum, but it has been produced by another method for several centuries in India. Here small porous earthenware jars of extreme width and small depth are filled with water and placed at night on a bed of straw in the open air. The straw serves merely as an insulator, and the porous jar permits the water to leak through, presenting a large evaporative surface. A strong wind blows here throughout the night and the temperature seldom falls below 60° F. However, the wind passing over the jars causes such a rapid evaporation by the absorption of the vapor into the atmosphere, that the liquid cools off sufficiently to produce ice. Sometimes sheets of ice as large as one-fourth of an inch thick are readily produced in one night, during which the temperature has not fallen below 60°. The evaporation of the water absorbs the heat from the water, cooling it, and finally absorbs the heat which goes into the ice to melt it and which when taken from the water produces ice.

Now, these phenomena if rightly understood are the fundamental principles back of the refrigerating machine. Water is unsatisfactory, since in order to produce cold it must boil away or evaporte at a temperature below that of surrounding bodies, and in order to do this the atmospheric pressure must be diminished almost to zero, and this is extremely difficult to obtain in practice with any degree of efficiency. Hence, other liquids which have a different range of boiling point with variation in pressure are used. A pound of water in changing to steam absorbs 966 B. T. U. from surrounding bodies and it is, therefore, very inefficient on account of quantity of heat absorbed per pound of water used. Hence, a liquid must be selected which has a high latent heat of evaporation, or a large heat absorptive capacity per pound of material used. Ammonia gas compressed and condensed into a liquid is found to satisfy these requirements better than any other substance and occupies a position next to water in this regard. A pound of ammonia liquid requires the addition of 560 B. T. U. to change it to ammonia gas. The material does not exist as a liquid at ordinary temperatures and when the liquid is produced and exposed to the atmosphere, its boiling point is 40° below zero; that is, the surrounding space is like a very hot furnace and causes it to boil away very rapidly.

Ammonia is not the only substance that can be used for this purpose. Carbon dioxide liquid has a boiling point much below that of ammonia, but its heat of vaporization is much less per pound of the material. Ordinary gasoline or naptha could be used with very favorable results for refrigerating purposes. Thus, a barrel of gasoline left exposed in the air will spontaneously evaporate, and, if the day is sufficiently cold, can almost be made to boil. This evaporation produces refrigeration by the absorption of the latent heat of vaporization of the gasoline from the liquid itself. This is so pronounced that an ordinary carburetter on a gas engine often freezes up. The air on mixing with the gasoline in the carburetter absorbs enough vapor to cool it by taking the heat required to do so from the liquid itself to a sufficient extent to freeze the moisture in the atmosphere in the inlet valve to the engine in such a manner as to completely stop this with ice. This is common occurrence and becomes more and more pronounced as more easily volatile oils are used in the engine. With some oils it is the chief objection to the use of the carburetter, and these have been eliminated with the injection directly into the cylinder and the consequent cooling of the cylinder walls by this means, aids in the operation of the engine.

Thus, a barrel of any volatile liquid, if its boiling point is below that of surrounding bodies at the pressure of the atmosphere, can produce refrigeration. A barrel of ammonia if allowed to evaporate in a room with an exhaust pipe for carrying off the gas, would cover itself completely with ice from the moisture in the atmosphere. Further, this ammonia liquid behaves precisely as water does. Increase in the pressure of the gas or air above the liquid raises the boiling point of the liquid and diminishes the heat required to change it to gas. Diminution of the pressure lowers the boiling point and increases its absorptive capacity for heat, thus making the refrigeration greater and more rapid.

Now, if liquid ammonia was a common commodity, or

could be pumped from wells as crude oil is, we would need no machinery to produce refrigeration. All the machinery required in a refrigerating plant is to save the ammonia gas and reconvert it into a liquid for use again. Thus the machinery is not refrigerating machinery in the strictest sense; it is simply a liquid producing machine. The refrigeration is inherent in the ammonia and occurs when it evaporates.

Since the ammonia is scarce and expensive, we must save it and use it over again. This is the reason for the machinery; it has nothing to do with the refrigeration. Now, in the reproduction of the ammonia liquid from the gas the process is identical to a similar one in steam work. Steam is produced from water in the steam boiler and used. It continues to be steam and is changed into water by means of a condenser. This condenser operates by lowering the temperature of the steam below the boiling point of the water and spontaneous condensation with the evolution of the latent heat of evaporation of condensation, which must be carried off by the cold water or the material will get hot and probably re-evaporate. Now, in ammonia gas similar conditions hold. The ammonia must be cooled until it is below its boiling point, and changes to the liquid and gives out the latent heat of vaporization, which it absorbs on becoming a gas. Now, the boiling point of a liquid varies with the pressure, and this explains the meaning of the compressor. Ammonia is compressed to such an extent, that if it were liquid its boiling point would be very high, so high that it could not be touched without burning. Under these circumstances the gas at this temperature and pressure if cooled off will fall below the boiling point and will become liquid. Then by a diminution in pressure the boiling point falls and it evaporates at a temperature below that of surrounding bodies, thus absorbing heat.

In reality a refrigerating machine is a heat pump. The ammonia, when it evaporates at the low temperature, absorbs heat as a sponge does water from the surrounding bodies. Its boiling point is then raised to a point above that of the surrounding bodies by compression, and the heat is drawn out by cold water very much as water is drawn from a sponge by squeezing. The analogy is almost perfect. Every bit of heat which is taken from the refrigerating room of an ice making tank, must go out in the condenser water, and the work which is used to do it must go out also in the form of heat. Thus if a certain quantity of ice is produced by a refrigerating plant, just that much heat, plus a definite known fraction, must be carried off in the condenser water. This accounts for the necessity of cold condenser water. The quantity of heat which water can take and carry away depends upon the amount of water and the rise in temperature. Sixty degree water is much more efficient than 80 degree water. Not only will less water carry away more heat, but by lowering the temperature of the ammonia gas still further, before condensation, the boiling point of the ammonia gas need not be so high for condensation to occur, and hence the pressure required to produce this boiling point need not be so great. Hence the work on the compressor is less and the efficiency of the plant increases with fall in temperature of condenser water.

The ammonia liquid leaves its barrel, or reservoir, and enters the cooling coils. Here it boils away, and if it should boil into the atmosphere, or at 15 pounds pressure, its boiling point would be 40 degrees below zero, and it would absrob heat rapidly from the surrounding bodies. It has been found in practice that ammonia pipes will cool surrounding bodies immediately in contact, or comparatively close, to within 10 degrees of their own temperature and will keep them there with little difficulty. Thus, an ammonia refrigerating system, where the cooling coils were connected with the atmosphere, would be able to cool to 30 degrees below zero. The ammonia vapor, as fast as produced would leak out into the atmosphere through the hole, or could be sucked into the compressor, where it is compressed and changed again to a liquid.

The amount of ammonia gas able to be collected in the cylinder of the compressor at one stroke depends simply upon its pressure. A compressor operates more efficiently at a high pressure, and hence, it does its work better the more gas it can collect per stroke and the higher the pressure. Hence, the pressure on the suction side of a compressor is allowed to rise until the ammonia boils at a temperature just sufficient to produce the liquid refrigeraton. Thus, in ice-making the boiling point of the ammonia is about 10 degrees above zero and the pressure for this boiling point is from 15 to 20 gauge pressure; that is, 30 to 35 pounds absolute pressure. By these means the amount of ammonia gas which goes into the compressor per stroke and the amount of ammonia liquid produced, and therefore able to be evaporated, increases with the suction pressure. Hence, the milder the refrigeration required the more efficient is the refrigerating plant. In order to make a room colder or produce more ice in a given time, the suction pressure is lowered, or the feed valve of the ammonia liquid is more completely closed, allowing less liquid to enter the evaporating or cooling coils, and hence, keeping the pressure of the vapor less. This explains the main details and principles back of the operation of an ammonia compression plant.

An absorption plant is identical in principle as far as the refrigeration is concerned, and is identical in conditions influencing the efficiency, only the compression is produced in another manner and the removal of the vapor from above the boiling liquid is also effected otherwise. The absorptive power of water for ammonia gas and the loss of this power with fall in temperature is utilized here. This machine, however, is rather uncommon, 95 per cent. of all refrigerating machinery being the one described. In general this 5 per cent. can almost be neglected in the general viewpoint, as the majority of engineers will seldom meet with other than the standard type.

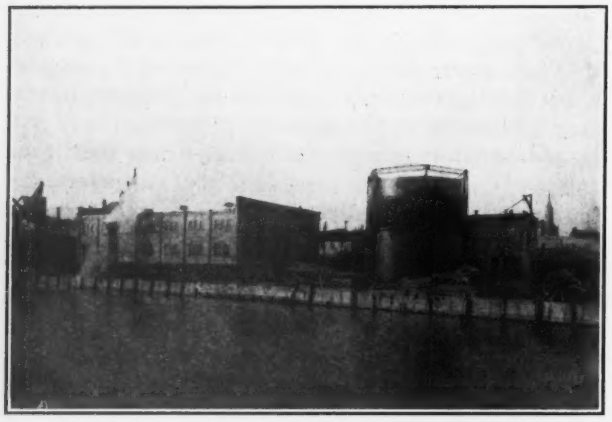
To test lubricating oil for acid, dissolve a crystallized piece of carbonate of soda about the size of a walnut in an equal bulk of water, and place the solution in a bottle with some of the oil. If, on settling after a thorough agitation, a large quantity of precipitate forms, the oil should be rejected as impure.

THE MILWAUKEE NORTHERN RAILWAY POWER PLANT

Producer Gas Plant Located at Port Washington, Wisconsin

About two month ago, the Milwaukee Northern Railway sent the first cars over its tracks between Milwaukee and Port Washington, along the western shore of Lake Michigan, and when the road is entirely finished the towns of Sheboygan, Fond du Lac, West Bend, Thiensville, Grafton, Cedar Grove, Barton, Kewaskum, Campbellsport and others will be brought into closer communication with the metropolis of Wisconsin. Besides marking another event in the history of interurban traction, the particular feature of this electrically equipped road is the design of the power-house, which contains 1,000 K. W. gas engines, driven by producer gas.

The power-plant, which furnishes the principal power for driving the electric cars, is located at Port Washington, on Lake Michigan. Two buildings comprise the power plant proper, one for the producers and one for the engines, generators, switchboards and protective apparatus. Both structures are of concrete, steel and brick construction, placed approximately fifty feet apart. The gas supply main is run outside of and along the entire length of the power-house from the producer plant. Coal for the plant is unloaded directly from Lake Michigan steamers onto the wharf and carried to the plant by a coal-handling system



Exterior of the Port Washington Gas Engine Power House

The gas for the engines is furnished by producers operating on the Loomis-Pettibone system. The present installation comprises two generating units, each consisting of a pair of gas producers connected to a common economizer, wet scrubber and exhauster. The gas is delivered into a holder of 30,000 cubic feet capacity. The normal rating of the present plant is 4,000 H. P., and it has a capacity of 25 per cent. overload for 5 hours' duration.

The brick building containing the apparatus is divided into a basement 19 feet in depth and a single story about 14 feet in height to the eaves. The operating or charging floor is about 6 feet above the level of the ground outside the building. A coal tank 50 feet long is located on the operating floor, with openings in front of the charging doors of the gas producers, thus bringing the fuel to points convenient to the man operating the gas plant. Hocking Valley bituminous slack coal, containing about 11,500 British thermal units per pound, is the fuel ordinarily used.

The plant is operated on the down-draft principle, the air being admitted through the charging door at the top of each producer, and the necessary suction being caused by an exhauster located beyond the wet scrubber. By this method the volatile matter and distillates are drawn through the deep bed of incandescent fuel and gasified, thus avoiding any tar extracting machinery, and enabling the system to produce gas containing 80 per cent. of the heat units possessed by the fuel used. Reverse runs of steam, generated by the gas passing through the economizer, or waste heat boiler, are occasionally made for the purpose of breaking up the fuel bed. The water gas made by this process mixes with the producer gas in the holder and slightly enriches it. The average calorific value of the gas as delivered from the holder is 125 British thermal units per cubic foot. The gas mains leading to the engines are equipped with Ludlow valves.

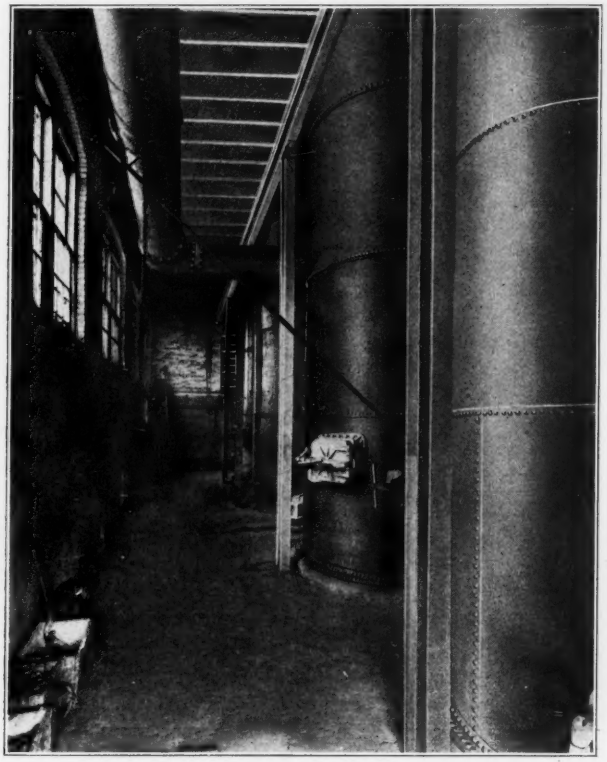
The generating units are three in number, each of 1,000 K. W. capacity, two of which are now installed; the third will be set up shortly. Each unit consists of a twin tandem horizontal double-acting Allis-Chalmers gas engine direct connected to a 405 volt, 25-cycle Allis-Chalmers alternator. Although the rating of each unit is given as 1,000 K. W., both engine and generator were designed with large overload capacities, the engine being capable of developing upwards of 2,000 H. P. and the generator having a corresponding capacity. Each engine has four cylinders, 32" in diameter by 42" stroke, and operate at 107 revolutions per minute.

The valve gear is of the cut-off type and the engine operates with constant compression, thus tending to insure smooth running under the highly variable loads to which it is subjected. The inlet gear consists of a main inlet valve of the single beat poppet type, eccentric operated. The mixture of the air and gas is effected before entering the cylinder by means of an annular mixing chamber located under the main inlet bonnet; the design and operation of this device is such that, at the instant of closing of the main inlet valve, there is practically no explosive mixture left outside the cylinder. The gas valve is of the double beat poppet type controlled by a variable lift rolling lever operated by a single link connection to the main inlet gear, the lift of the valve and consequently the amount of gas admitted and the time of admission being regulated by the governor. The exhaust gear is of the single beat poppet valve type, eccentric operated, and is in this respect a duplicate of the main inlet gear. The location of the exhaust bonnet, with its valve, is at the bottom of the cylinder, where the dirt is removed by the action of the exhaust gases. The entire exhaust mechanism may be lowered out of place to allow inspection and regrinding of the valve, and to swing the valve chamber, with the valve and operating mechanism out to one side, where it can be reached by the crane hoist. The removal of one pin, either in the inlet or exhaust mechanism, allows the removal of either the inlet or exhaust bonnets, with their

valves and entire operating mechanism, without disturbing any adjustment whatever.

The igniters are electrically controlled and so arranged that the time of ignition is regulated by a hand wheel. Direct current at 60 volts is used in the ignition system. Duplicate igniters are provided at each end of the cylinder to insure prompt firing of low heat value gases, and also to avoid the danger of shut-down, due to short circuit. A motor-generator set furnishes current for the igniters.

The air-starting device consists of a small poppet inlet air valve at each end of each cylinder, with a main distributing valve operated by the layshaft. Air is admitted to each cylinder in turn at what would be the explosion stroke. As the high compression carried prevents the engine from stopping on the dead center, the engines, being twin tandems, will start from any position.



Loomis-Pettibone Gas Producers at Port Washington, Wis.

All wearing surfaces, including the main bearings, slides, crank and cross-head pins, are arranged for a continuous oiling system, and the cylinders are lubricated by timed admission of the cylinder oil, sight-feed oil pumps being used.

The water-cooling system includes provision for cooling the cylinder walls, cylinder heads, pistons, piston rods, exhaust valves and exhaust bonnets. Water is circulated by means of two Morris and two Deming pumps, each driven by an induction motor.

The generators, which are of 1,000 K. W. capacity, are of the revolving field type. Three-phase current is generated at 405 volts and 3,000 alternations or 25 cycles. Current for excitation is furnished by two 50 K. W., 120 volt, D. C. generators, driven by vertical gas engines. These do not appear in the photograph of the station interior, being temporarily in a different position from that shown by the plan.

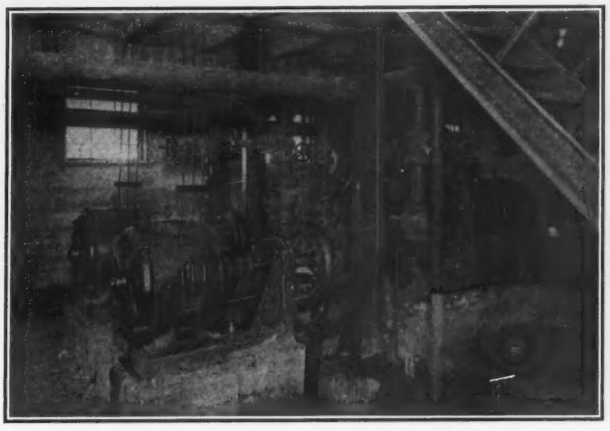
The current from the main generators is delivered to a six-panel switchboard, having three generator, one exciter and two transformer panels, which contain all the necessary

Operating Floor in Gas Producer House

switches, circuit breakers, and instruments for properly handling and regulating the equipment.

From the switchboard the current is carried to the step-up transformers and also to the rotary transformer switchboard. There are seven step-up transformers of 500 K. W. capacity each, arranged in two banks of three each, with one held as a reserve. These transformers raise the voltage from 405 volts to a maximum of 22,000 volts, with intermediate tap to allow the voltage to be varied if desired.

The current is carried from each bank of transformers to



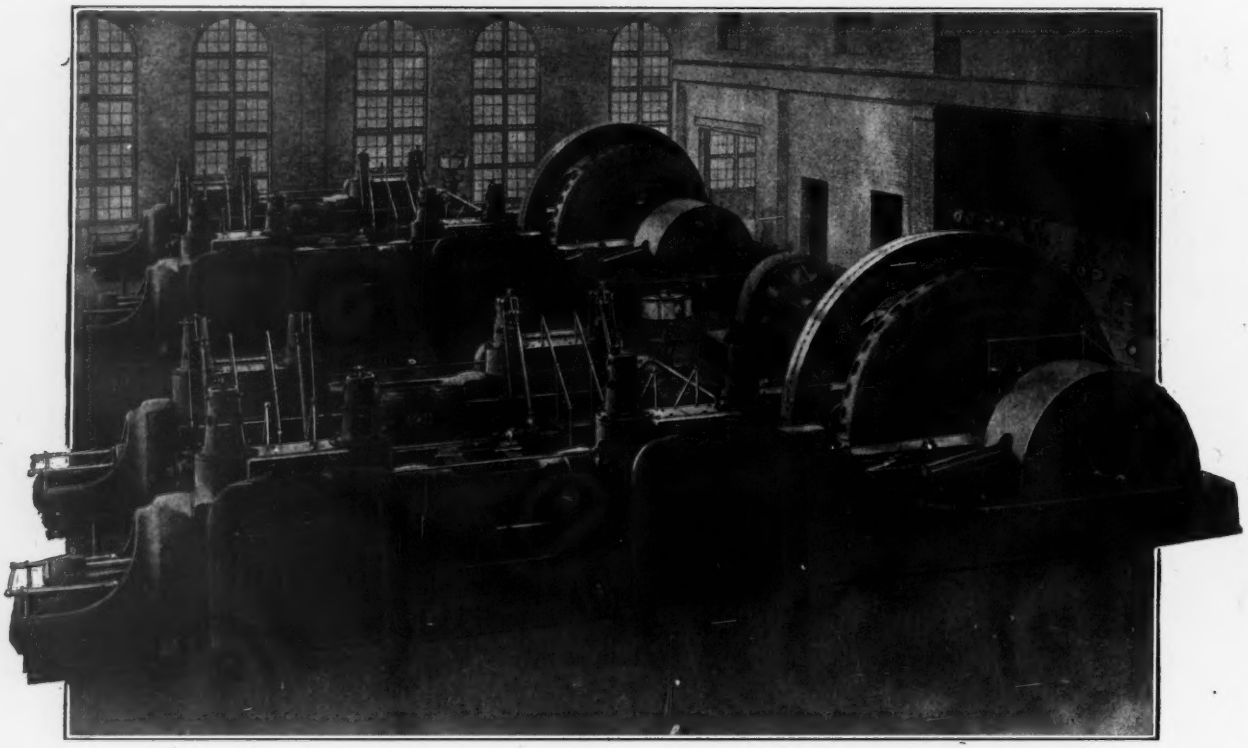
Electric Pumps Used for Cooling the 200 H. P. Gas Engines

the high tension bus through three oil switches of 40 ampere capacity each, in each circuit, in addition to plug switches at each transformer to allow for speedily cutting out any transformer in case of break-down. From the high tension bus three transmission lines are led away, each with automatic oil

circuit breakers of 40 amperes capacity in circuit. The station apparatus is protected from lightning by means of an equipment of low equivalent lightning arresters and oil immersed choke coils connected to the high-tension bus.

For supplying nearby portions of the line two 300 K. W. rotary converters are provided in the main station. They have 6 poles and run at 500 R. P. M., taking three-phase alternating current at 405 volts and delivering direct current at 650 volts.

The converters are connected to a six-panel switchboard having two alternating current rotary panels, two direct current rotary panels and two direct current feeder panels with two feeder circuits, which contain all necessary switches, circuit breaker, and instruments for handling and regulating the current and apparatus. The converters are protected from lightning by means of arresters on each feeder circuit.



1250 K. W. Gas Engines and Generators at the Plant of the Milwaukee Northern Railway Co., Pt. Washington, Wisconsin

There are eight sub-stations, located at the following points along the right of way: Burleigh, Cedarburg, Georgia Avenue, Marblehead, Brown Deer, Cedar Grove, West Bend and Campbellsport, two of which have each two 400 K. W., 600 volt rotary converters, and six 125 K. W., 22,000/405 volt, step-down, oil-cooled, static transformers. The remaining six sub-stations each have two 300 K. W., 650 volt, rotary converters, and six 100 K. W., 22,000/405 volt, step-down, oil-cooled static transformers, of the same company's build.

Each sub-station is protected against lightning by means of three 22,000 volt, low-equivalent lightning arresters and auxiliary apparatus; each sub-station has an eight-panel switchboard, having two alternating current rotary panels, two alternating current starting-panels, two direct current rotary panels and two feeder panels, except in the Cedarburg sub-station, where there are three feeder-panels.

All sub-stations have 22,000 volt, 20 ampere, automatic oil-circuit breakers on outgoing transmission lines and on the transformer-circuits, except at Cedarburg, which has 40 ampere breakers on outgoing transmission lines. The Cedarburg sub-station has also 22,000 volt, 40 ampere oil switches on the incoming transmission lines, and three 2,000 volt, 20 ampere automatic oil-circuit breakers in the high-tension equalizing bus.

The low-tension cables are triple-braided, weather-proof wire supported on insulators, the insulated covering being relied upon only for protection from accidental contact and as a spacer. All high-tension wires are bare, mounted on suitable insulators.

Except for the short distances in the centers of some of the larger towns, the roadbed is located on its own right of way. The general absence of grade-crossings and curves permits a high-speed schedule. The roadbed is ballasted with gravel, cedar ties being used on straight line construction and oak ties for the curves. Cedar poles with side-arm construction are used on the private right of way, and wrought-iron posts, with span construction, are used in the cities. The type of rail used is the 70-pounds "T" outside of the cities and 95-pounds "T" rail in the cities. The cars are equipped with four 75 H. P. motors and are designed to run at a possible maximum speed of 54 miles per hour. The total trackage of the road is 30 miles at the present time, but when completed, the line will have 112 miles of track. Mr. H. J. Pagal is operating superintendent of the road.

ENGINEERING IN A NUTSHELL

Answers to Questions That Won First Prize in the Michigan N. A. S. E. Contest

By Edward J. Rose.

Subject No. 16—Hydrostatic Tests of Steam Boilers.

The science of hydrostatics treats of the conditions of the equilibrium of liquids and the pressure they exert, whether within their own mass or on the sides of the vessels in which they are contained.

The principles of this science to conducting and raising water in pipes is known by the name of hydraulics. So the hydraulic press or pump is used in all cases where great pressure is required. It is also used to test the strength of steam boilers. The pressure is found by multiplying twice the thickness of plate by its tensile strength in pounds, divide by diameter of boiler, and divide this result by six. This gives safe working pressure. The usual way is to add one-half more for test pressure and if the boiler goes through this test all right, it is safe to run it at two-thirds of test pressure.

If a hydrostatic test is made on an old boiler, go over it carefully with the hammer for broken braces, weak and corroded spots, and figure for safe working pressure on the thinnest place found in the boiler. Fill boiler full of water and gradually heat it until the desired pressure is reached. By this mode of testing by hot water pressure, the heated water is expanded and is more elastic than cold water, and is not so liable to strain the boiler. The hot water expansion test is very efficient and safe when testing old boilers, and as a detector of leakages it has no rival.

The application of an hydrostatic test on new boilers enables faulty caulking to be made good before the boiler has left the works and before a leak has time to enter on its career of corrosion.

The duty of inspecting a new boiler or witnessing the hydrostatic test properly belongs to one of the regular inspecting companies, who have men in their employ specially trained for such work.

Now as far as new boilers are concerned, the application of hydaulic pressure unaccompanied by careful inspection and gaugings may be almost worthless, while with these additions, it is extremely valuable, and is a precaution that should not be neglected.

Subject No. 17—The Use of the Steam Indicator.

By the use of the steam engine indicator we are enabled to read the inner workings of a steam engine; point them out with unerring accuracy, detecting errors, mis-adjustments, waste and lost motion, and it may be safely said that there is no device in the entire range of mechanical inventions that has aided so much in the development and perfecting of the steam engine, and it is a most necessary adjunct to the engine room. The engineer who is so fortunate as to possess the knowledge necessary to operate an indicator, will find that his position is not only more secure to him, but his employers will be more apt to show their appreciation in a substantial manner.

There are three main objects for determination of which the indicator may be employed.

First.—To serve as a guide in setting the valves of an engine.

Second.—To determine the indicated power developed by an engine.

Third.—To determine with a feed water test, the actual amount of steam consumed and the economy with which the engine works.

Any derangement of the valve gearing is revealed in the diagram, such as tardy admission or release, low initial pressure or high back pressure or absence of compression, either one of which causes an increased consumption of steam for performing the same amount of work.

Now, as the angular position of the eccentric controls all the movements of the valves, any improper proportions of lap and lead, as well as wrong position of eccentric, will be detected by the indicator diagram. The valves being in proper adjustment, the indicator diagram shows whether the pipe and passages for the admission and exhaust of the steam are of sufficient size. A good indicator card should conform to the following requiremtns:

First.—The back pressure line should be parallel with the atmospheric line, and measuring with the indicator scale, should not show more than one or two pounds pressure if the engine is non-condensing.

Second.—The admission line should be perpendicular to the back pressure line.

Third.—The steam line should be parallel with the back pressure line.

Fourth.—The point of cut-off should be sharp and well defined.

Fifth.—The expansion curve should approximate the theoretical curve.

Sixth.—The exhaust curve should have a quick drop. The initial pressure should not be more than three pounds less than the boiler pressure and if exhausting directly to the atmosphere, the back pressure should not exceed one pound.

Much can be learned by applying the indicator to the steam and exhaust pipes, using the same mechanism for driving the paper drum as that used when the indicator is operated at the cylinder.

The indicator is also invaluable for measuring the amount of power developed by an engine; the diagram gives what is termed the indicated power of an engine which is the power exerted by the steam, which consists of the net power delivered, and in addition that consumed in the engine itself.

Power is often rented by the use of the indicator. The process of measuring power thus used consists in indicating the engine first with machinery in operation and then with the driving belt or shaft thrown off. The difference in the amount of power developed in the two cases is the desired result.

A VOICE FROM THE BOILER ROOM

Methods of Cleaning, Firing and Handling Ashes in a Plant Containing Horizontal Tubular Boilers

By L. C. Tucker.

From time to time, various methods of operating boilers and the way in which they should be fitted up, are discussed by your readers, so that perhaps a few words regarding the plant where I help to keep the vapor rising, may be of interest. There are five 72" x 20' horizontal return tubular boilers in the plant, each containing 36 square feet of grate surface and 1440 square feet of heating surface. They are equipped with dumping grates, divided in the center, making it possible to dump one side at a time. We have a 5/8" natural draft, and the coal bunred is the best we can buy.

The plant is located within 200 feet of the river bank, the coal being brought to the plant in barges, unloaded with a steam digger and hoist to a belt conveyor, which conveys the coal to storage bunkers having a capacity of 1500 tons. The bunkers are elevated, fitted with shutes, from which the coal is taken in hand cars holding one ton, to the boiler room, where it is shoveled by hand from the cars onto the grates.

The boiler room floor, with the exception of a space 2 feet wide directly in front of the boilers, which is of brick laid in cement, is of concrete and extends out under the coal bunkers. The coal cars are fitted with smooth tire wheels. Forty-five tons (2000 lbs.) of coal are burnt per 24 hours, and two men bring it into the boiler room, one man on each shift, these men working twelve hours per day. Six of us put this coal under the boilers, two firemen on each shift, the firemen working 8 hours per day. The average water evaporation is 730,000 pounds for the 24 hours.

The five boilers are run continuously, except when one is shut down for cleaning, etc. Our feed water is of fairly good quality, so each boiler is opened up only once in 10 weeks. This leaves only four boilers to do the work, and if there are any stationary boilers forced harder than these are at this time, I hope it may never be my misfortune to see them. It is only a short drag, however, because 24 hours from the time a boiler is cut out, it is back on the line again; that is, provided nothing more than regular cleaning has to be done. Many readers may think that these boilers would be ruined, because of the very short time taken to clean them, but such is not the case, for these boilers have been cleaned within 24 hours for several years, and I doubt if boilers in better condition can be found. Leaky tubes and seams are unknown at this plant.

The method used for cleaning is as follows: Suppose No. 3 boiler is about to be cleaned. The water is run low, the feed valve shut and the fire burnt down. When the boiler has stopped making steam, the fire is pulled, the main stop valve shut and the boiler left stand for 6 hours. The safety valve and fire doors are opened wide and the damper left open as far as possible, without affecting the draft on the other boilers. When the pressure is all off the boiler, the top manhole is removed, the blow-off opened and cold water supplied to the boiler through manhole by a 3" fire hose. Another hose, 3/4" carrying 65 pounds water pressure, with an 1/8" nozzle, is used to cool the inside walls, the walls and boiler shell being given a good washing down and the soot in the combustion chamber is thoroughly wetted.

The use of the large hose is now discontinued, and the boiler allowed to drain. A Dean tube cleaner is next brought into play, which knocks the scale off the outside of the tubes and blows the soot from the inside. The boilers are fitted with a manhole under the tubes in the front head, and with a handhole in the rear head; these are now taken out. Taking out a handhole plate in the combustion chamber of a boiler that was generating steam only a few hours before, is not so hot a job as one would think, because the water has cooled it off and the damper, during this operation, is wide open.

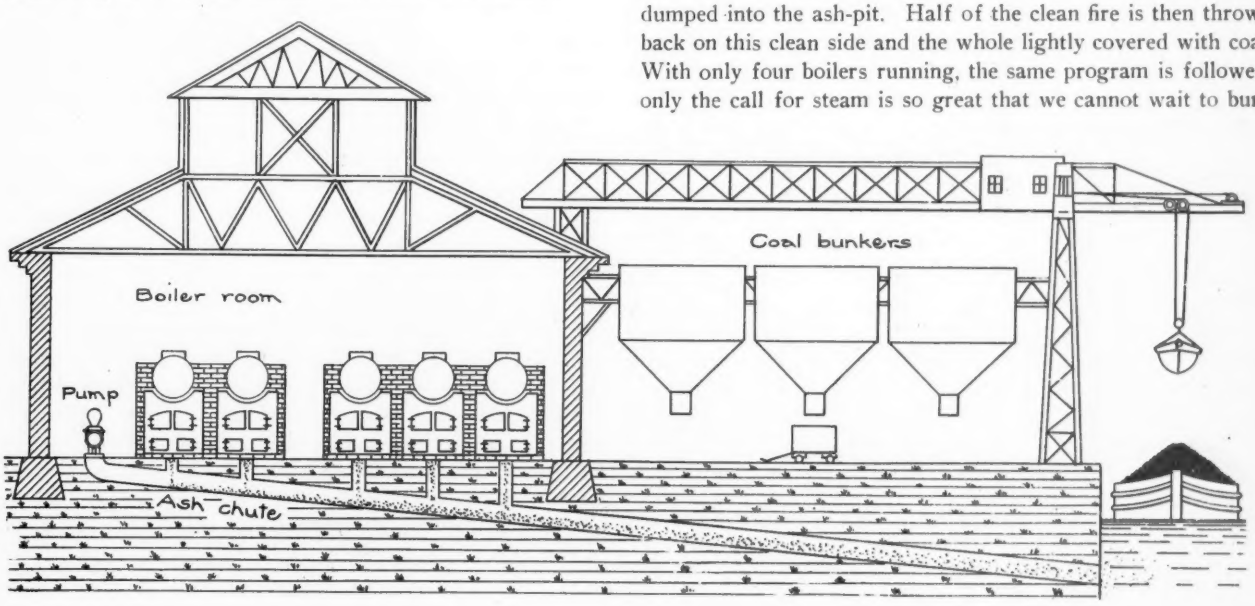
The inside of the boiler is now given a thorough washing with a smaller hose, after which a man goes into the boiler with a small pneumatic hammer, fitted with a copper head, and any scale lodging on the sheets comes off in a hurry. While the man is in the boiler, the combustion chamber door is open; also the damper. The ash-pit fire-box and smoke-box doors are shut, so that a good draft is pulled through the boiler. The soot in the combustion chamber is then thrown over the bridge wall through the dumping grates into the ash-pit, and is disposed of in the same manner as the ashes. Sandwiched in between the above program, several little matters have been attended to, such as testing the steam gauge, looking over the water column connections, internal feed pipe, rivets, tube ends, stays, brickwork, grates, etc.

The boiler is now absolutely clean inside and out, and the work of closing up is begun, the top manhole plate being left off. The fire-hose is again brought into play, this time with an ejector and its necessary steam connection. The boiler is quickly filled with hot water, the manhole plate replaced, green coal spread on the grates, with the exception of a small space in front, which is covered with live coals from one of the other boilers, and the job is done. It is not quite so easy as reading it, but still it is not such a bad job at that, as everyone works together and for each others interest.

When cleaning the boilers, two extra firemen are engaged to fire the boilers in operation and two of the regular firemen clean the boilers as stated. These two men understand their business thoroughly, and everything glides along as smooth as grease. The boiler is cut out at midnight, the cleaners coming on duty at 6 o'clock the next morning. They work until the job is done, usually until 6 P. M.; then fire is started at this time and six hours are taken to raise steam to working pressure. Washing down the hot walls and boiler may be criticised by some engineers, but it is only a small stream of water issuing from a small nozzle, and the man holding it keeps it moving.

The ashes from the boilers are disposed of as follows: A cast-iron sluiceway, round and open at the top, runs along the front of the ash-pits, the opening being on the level with the bottom of the pits. One end connects with the river directly

beneath the steam digger, and the other end to the discharge of a large pump. When the time comes to hustle out the ashes, which is every six hours, the coal wheeler pulls the ashes with a large hoe and the pump is started. This pump is run just 30 minutes by the gauge-board, and if at the end of that time all the ashes have not disappeared from the ash-pits, sarcasm is heaped upon the coal wheeler's head to such an extent that he shrinks away to a remote corner, overcome with shame.



When the plant was built, the steam digger was erected first, and all sand used in the construction of the plant was taken from the river bottom. The ash-sluiceway was lead to a point over this hole, the supposition being that the ashes would drop into it, when they could be removed to scows by the digger. The hole filled up all right, but not with ashes, and where they go is a mystery, as a boat's crew, taking 20 soundings a minute for a day last spring and fall, failed to detect any decrease in the depth of the river.

The boilers have overhanging fronts, and the method of piping up water columns and feed pipes makes a neat-looking job. The feed pipe enters on one side of one boiler and on the opposite side of the next, the same being true of the water columns. The external feed pipe enters one end of a steel bushing just above the tubes at the front head, the internal feed pipe being screwed into the other end of this bushing. This does away with the taking down of the internal feed pipe, should it become necessary to renew nipple of external pipe leading into the boiler, as would be the case if this nipple had a long thread cut on its end and was screwed directly into the head of the boiler, and the internal feed pipe was connected to end of pipe extending through head with a coupling. The internal feed pipe extends along one side of the boiler for about 16 feet, when it turns and goes across to the other side, an elbow turning the feed down between tubes and shell. The blow-off drops from the bottom of the boiler to below level of combustion chamber floor, this vertical piece of pipe being protected with a split-tile sleeve, held to gether with lugs. The horizontal run of pipe under floor is placed in a brick conduit fitted with tile covers. Feed water is supplied by a power pump, or in case of accident, by a steam pump or injector.

Our method of cleaning the fires is also simple and easy, the work falling on the coal wheeler. Each fire is cleaned every twelve hours, but it is done in such a way that it takes several hours to make the round. With the five boilers running, one side of a fire is burnt out, then dumped into the ash-pit. All of the clean fire on the other side of grate is thrown over on the clean side with a throwing-over bar. The dirt which is left is dumped into the ash-pit. Half of the clean fire is then thrown back on this clean side and the whole lightly covered with coal. With only four boilers running, the same program is followed, only the call for steam is so great that we cannot wait to burn one side of a fire down, but have to throw it to one side before dumping that half of the grate.

The throwing-over bar is a very handy tool, and while using it, one can imagine they are rowing a boat, during a half holiday, on the lake. It is shaped like an oar, having a handle of about 1 in. iron, with a flat blade at the end about 4 in. wide and 3 feet long. Taking it all in all, we get along nicely. There is always plenty of work to do, but we have a little time now and then to hear a funny story, or discuss the methods to be pursued during an emergency.

A New Aluminum Storage Battery.

A new aluminum accumulator has recently been invented by Dr. H. Fritz Reinhold, of Newark, N. J., which it is claimed will revolutionize the storage battery industry. Aluminum is very desirable for storage batteries on account of its lightness, cheapness and specific gravity. The specific gravity of lead is 11.4 while that of aluminum is 2.67, so that a battery containing the last-named metal will be one-fifth lighter than one containing lead, and is far superior to the Edison nickel-iron element which is only seven-ninths lighter than lead. It is also claimed that the battery can be rapidly charged and discharged without affecting the plates. The electrolyte is a special compound of an inexpensive nature, it costing but a few cents to fill a cell of medium size. If the new battery possesses all the advantages claimed for it, it will fill a long-felt want in the electric power station, particularly for traction purposes.

GAS ENGINES AND GAS PRODUCER PLANTS

Over 300 Gas Producer Plants Now in Operation in the United States

The fuel consumed in the ordinary manufacturing plant operated by steam power yields less than 5 per cent. of its available energy in useful work. The superintendent of one of the most efficient steam plants in existence to-day estimates the total losses in a year's operation of the plant at about 90 per cent.—the utilized energy at about 10 per cent. It is this wasteful consumption of our most important fuel, whose very existence, as measured by competent experts, is limited to a few hundred years, that has brought about the rapid development of one of the marvels of modern invention—the gas-producer and gas engine. It is estimated that a plant of this type, properly operated, will utilize more than 20 per cent. of the available energy in the fuel consumed.

The gas engine came into general use in the latter part of the nineteenth century, but large engines of this type have been constructed only during the last five or six years. Recent developments indicate that the replacement of steam engines by producer-gas plants is destined to be one of the two great factors in the economical production of power for manufacturing and transportation purposes—the other being centralization of power production and distribution.

For a long time the natural fuel of these internal-combustion engines was city gas, but that was too expensive except for engines of small capacity. Cheap gas was essential for the development of the engine, but the early attempts to produce it were somewhat discouraging. The theoretical possibilities of the internal-combustion engine operating on cheap fuel promised so much, however, that difficulties which seemed almost insuperable have been overcome; and as a result of improvements in the production of cheap gas directly from fuel through the aid of the gas producer, the development of large-sized gas engines has been exceedingly rapid. Only seven years ago a 600 horse-power gas engine exhibited at the Paris Exposition was regarded as a wonder; to-day four-cycle, twin-tandem, double-acting engines run as high as 6000 horse-power.

In view of the possibility that the gas engine, with its gas producer, may displace the steam engine, the fuel problem became so important that the Government made special provision for producer-gas tests at its fuel-testing plant installed in connection with the Exposition at St. Louis. These tests have furnished valuable data on the relative consumption of coal per horse-power per hour when used by the steam plant and by the gas plant. By means of the producer-gas plant, which was installed in 1904, 162 tests have been made on bituminous coals, lignites, and peats from 26 States.

All of the tests, whether on bituminous coal, lignite, or peat, were made in a producer of one size and type—a type designed primarily for use with anthracite coal—and with every coal that was run through the producer the results were more than satisfactory. Especially noteworthy is the fact that several low-grade coals and lignites that have proved of little value or even worthless under the steam boiler gave excellent results in the gas producer.

About twenty companies in the United States are manufacturing gas producers for power purposes. At least twelve of these are fully established on a commercial basis and are in a position to give proper guarantees when installing plants. Over 300 gas-producer power plants, ranging in size from 20 to 6000 horse-power, are now in operation in the United States. One company alone reports twenty-odd installations, averaging over 2000 horse-power each, and nearly as many more, of about the same size, contracted for or now being erected. The number of installations and the persistent development have already led the National Board of Fire Underwriters to issue special rules and requirements for the "Construction, installation, and use of coal-gas producers (pressure and suction systems)." Of the total installations about two-thirds are suction plants, operating on anthracite coal, a few using charcoal. Bituminous coal is used in 15 to 20 per cent. of the plants installed, but this proportion probably covers 65 to 75 per cent. of the aggregate horse-power rating.

"The situation as a whole at the present time," says Mr. Fernald, "seems to be very favorable for the gas-producer plant, not only as to cost of installation, operation, and maintenance, but also as to reliability. The successful demonstration at the Government fuel-testing plant that bituminous coals, lignites, and peats can be utilized with great economy in these plants, should lead to an increase in the use of this form of power in a few years that may surpass even the most sanguine hopes of the manufacturers."

Of the centralization of power development and distribution Mr. Fernald says: "It would seem ridiculous to predict the immediate doom of the steam locomotive, yet one of the officials of the New York Central Railroad has publicly stated that within ten years, in his opinion, there will be no steam locomotives operating on the New York Central road. Already the New York Central has substituted electric for steam power on its lines from New York City to a point about 40 miles from Grand Central Station, and it is rumored that before long electric trains will be running on this road from New York to Buffalo..... These rapid changes are leading to one end—the centralization of power development and distribution. Now that it is commercially possible to transmit electrical power for distances of 250 miles or more, a central plant could distribute such electric current for a distance of 500 miles—that is, for 250 miles on all sides of the plant—thus covering a circle comprising almost 200,000 square miles—an area nearly four times the size of the State of Illinois. The logical location of such a plant is at or near the mines. With ten or twelve of these great central plants located at the various mining centers, the great railroads of the United States can send their trains speeding from the Atlantic to the Pacific coast; and the passengers, as well as the towns through which the trains pass, will be entirely freed from the usual annoyance of smoke and cinders, and the disastrous fires caused by sparks from locomotives will be a thing of the past."

A TALK WITH A CHIEF ENGINEER

The Measurement of Candle Power and the Meaning of Vacuum

By William Kavanagh.

Talk No. 8.

On entering the Chief's engine room, one week after his instructive talk on the impossibility of burning ashes, air or water, and his clear explanation of the application of superheaters and superheated steam, I found him talking to a lamp salesman, who was introducing a new style of incandescent

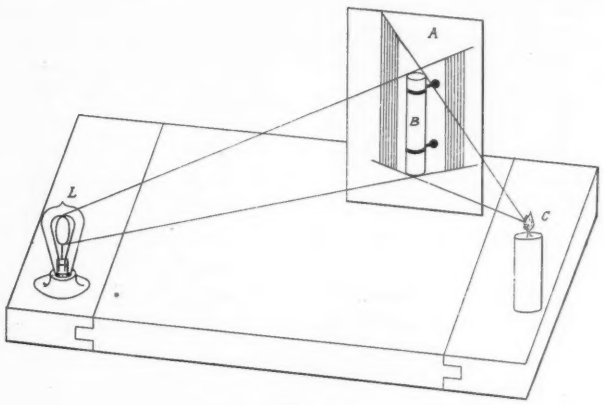


Fig. 1

lamp. The salesman was urging the Chief to give his lamps a trial, and as he proved that the lamps would give satisfaction in every respect, such as the length of useful life, candle-power, etc., the Chief gave him an order for the lamps.

When the salesman had gone, I asked the Chief to explain the methods by means of which the incandescent lamps were measured for candle-power, and while he was explaining this, Kingsley came in to get some pointers about a first-class engineers' examination, which he was about to take. The Chief's remarks were therefore more pointedly aimed at Kingsley, especially as this subject was one of considerable importance to the operating engineer. The Chief asked Kingsley if he knew the size of the standard sperm candle, to which Kingsley replied that he understood that the standard candle weighed one-sixth of a pound, that it was seven-eights of an inch in diameter, and burned at the rate of 120 grains per hour. "That is correct," replied the Chief, "and it is this standard candle that is used in the United States and England for measuring candle-power."

"The accurate measurement of light is called photometry," continued the Chief, "and the room in which the measurements are to be made must be totally dark. The simplest method makes use of a standard candle, and the lamp to be tested is placed on a table, as shown in Fig. 1. A screen is erected at one end of the table as shown at A, and an opaque body, such as a rod of iron or brass is placed between the lights and screen as shown at B. Two shadows will now appear on the screen and by moving the lights until the shadows are equal, as determined by the eye, we are thus enabled to find the candle-power of the lamp. The candle is shown at C and the lamp to be tested is shown at L, and by squaring the distance that the lights are from the screen, the candle-power of light L can be determined. For instance, if C is one foot away from the screen and L is four feet, then the relative power of the lights will be as 1 to 16. The farther the light is away, the less intense the shadow becomes, and its intensity is determined by a law known as the law of inverse squares, which is illustrated in Fig. 2. The standard candle is shown at C, and if at a unit distance, say one foot or one yard, a screen D is placed, having some specific size, say one square inch or one square foot, the divergent rays from the candle will cover this area. If now screen D is removed, and another screen placed at E, twice the distance from C to D, the intensity of the light will be only one-fourth as intense, because it is spread over a surface four times as great. If a screen be placed at F, three times the distance from C to D, the light will be only one-ninth as intense; hence it can readily be seen that the intensity of light varies inversely as the square of the distance from the source of light. These are the fundamental facts upon which candle-power is measured, so that you see, Kingsley, an engineer must know something nowadays of photometry or the methods of measuring light. Of course, there are numerous methods, very much more refined, for finding the candle-power of a lamp, but the one I have described is very simple and practical."

As Kingsley's mind was full of the examination he was about to take, he asked the Chief to explain to him the word vacuum and its formation, as he knew that would be one subject that would be asked him. The Chief began his explanation as follows: "You know, Kingsley, the information about a vacuum that is given in some books that are written for engineers, is often misleading and usually confuses the mind of the average reader. One definition defines a vacuum as a space void of pressure or matter, and I want to mark the word 'matter' as I proceed on this subject."

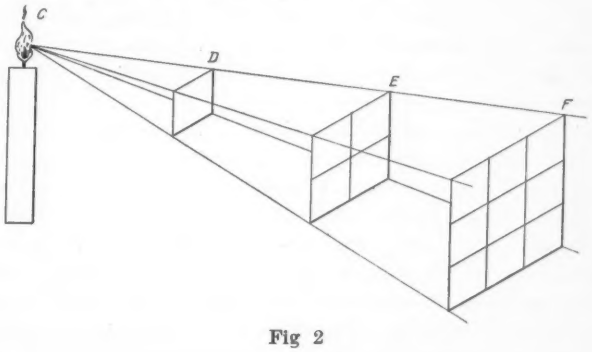


Fig 2

"In one of my previous talks, I explained how heat and cold could be measured on a scale, the dividing point being indicated by a zero mark, all degrees of heat running toward the right hand being considered as positive and those on the left hand being considered negative. The pressure can also be considered in the same way, measuring positive or negative pressure

to the right or left of atmospheric pressure, which is taken as 14.7 pounds per square inch at sea level. A vacuum has its maximum or minimum of negative pressure depending upon the various number of degrees which it approaches or recedes from what is known as a perfect vacuum. A perfect vacuum is impossible to obtain in practice, owing to the fact, that no matter how much air or gas is pumped or taken from the vessel in which a vacuum is desired, the remaining air or gas will expand and fill the vessel, hence the almost impossibility of practically producing a perfect vacuum. It can thus be seen that the more perfect the vacuum, the greater will be the atmospheric pressure exerted on the surface of the vessel containing the vacuum, so that the formation of a vacuum is an unbalancing of a portion of the atmosphere. This is the same principle which enables a pump to lift water or other liquids. Before a pump can lift a drop of water, it must first displace a sufficient quantity of air from within the cylinder before the pressure from without can force the water to enter the cylinder, and it is the function of the pump to unbalance the pressure.

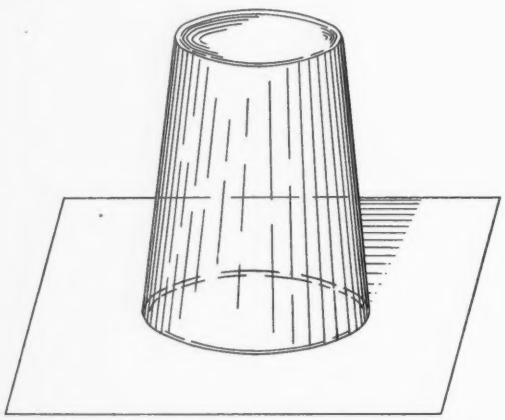


Fig. 3

"To illustrate the proper meaning of the word vacuum, I want to perform an experiment that will help you to grasp it." The Chief filled a glass full of water and placed over the top a piece of paper large enough to cover it. He then inverted the glass, as shown in Fig. 3, and the water did not fall out. "You see," continued the Chief, "it is not the paper that is holding the water in the glass, but it is the atmosphere. From this experiment we learn that a vacuum must exist in the glass, otherwise the water would fall out.

"The pressure of the atmosphere is 14.7 pounds per square inch at the level of the sea, and if a perfect vacuum is formed, the pressure exerted by the atmosphere would sustain a column of mercury 29.9 inches in height or a column of water 33.9 feet high; from which we learn that mercury is practically 13.24 times heavier than water. The engineer takes advantages of the vacuum in many ways, such as the lifting of water, the formation of vacuum in a condenser, its application to siphons and the heating of buildings.

"The formation and application of vacuum to the condensing engine, must be applied intelligently, because, as the vacuum is increased, the temperature of the feed water will be decreased, so that under some conditions it is necessary to investigate the proper point wherein the greatest benefits will be obtained. In some plants, the most efficient point is reached when the vacuum gauge registers 25 inches, in which case the temperature of the feed will be 135 degrees. If, however, a hot water heater is connected between the cylinder and condenser, the higher the vacuum formed the greater will be the amount of heat absorbed from the exhaust steam."

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Factors of Safety and Maximum Boiler Pressure.

The Board of Boiler Rules of Massachusetts have recently adopted the following regulations pertaining to the maximum pressure on boilers and their factor of safety:

MAXIMUM PRESSURE ON BOILERS.

1. The maximum pressure allowed on any steam boiler constructed wholly of cast iron shall not be greater than twenty-five (25) pounds to the square inch.

2. The maximum pressure allowed on any steam boiler the tubes of which are secured to cast-iron headers shall not be greater than one hundred and sixty (160) pounds per square inch.

3. The maximum pressure allowed on any steam boiler constructed of iron or steel shells or drums shall be calculated from the inside diameter of the outside course, the percentage of strength of the longitudinal joint and the minimum thickness of the shell plates; the tensile strength of shell plates to be taken as fifty-five thousand pounds per square inch for steel and forty-five thousand pounds per square inch for iron, when the tensile strength is not known.

FACTORS OF SAFETY.

The lowest factors of safety used for steam boilers, the shells or drums of which are directly exposed to the products of combustion, and the longitudinal joints of which are of lap-riveted construction, shall be as follows:

(a) Five (5) for boilers not over ten years old.

(b) Five and five-tenths (5.5) for boilers over ten and not over fifteen years old.

(c) Five and seventy-five hundredths (5.75) for boilers over fifteen and not over twenty years old.

(d) Six (6) for boilers over twenty years old.

(e) Five (5) on steam boilers, the longitudinal joints of which are of lap-riveted construction, and the shells or drums of which are not directly exposed to the products of combustion.

(f) Four and five-tenths (4.5) on steam boilers, the longitudinal joints of which are of butt and strap construction.

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An interesting engine repair, which shows the ingenuity which an engineer must often display, was made on the ocean liner Eagle Point. When in the middle of the Atlantic, the crank shaft broke on the triple-expansion engine and the boat was tossed unmercifully by the storm that was raging. The engineer, W. Jack, after investigation of the broken shaft, saw that it was broken in the section that worked on the intermediate cylinder, and he therefore decided to take out that section, move the high-pressure crank shaft over into its place and run the engine compound instead of triple-expansion. The engine was practically dismantled, and for 10 days the men worked day and night replacing the three-ton crank shaft while the boat was rolling in the trough of the seas. With the crank-shaft in place, bolted to the low pressure crank-shaft, the connecting rod and valve gear was adjusted, and the boat came into port under her own steam.

DESIGN OF A GAS ENGINE

Comparative Advantages of the Two-Cycle and Four-Cycle Types

By A. Edward Rhodes.

Having completed the design of a vertical gas engine of a particular size, it might be well to look into the advantages and disadvantages of the two general classes of gas engines—the two-cycle and four-cycle. In both the two or four-cycle engines there are four operations or series of events that go to make up what is termed a "cycle," which consists in drawing in the fresh charge, compressing and firing it, expanding and

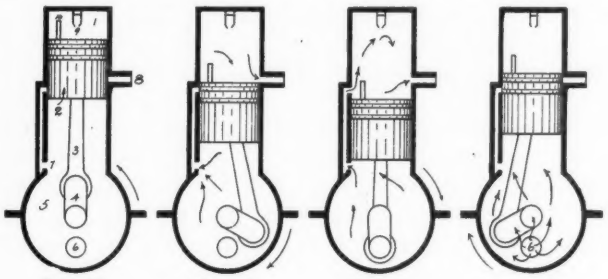


Fig. 29 Fig. 30 Fig. 31 Fig. 32

giving power to the engine, and the expulsion of the waste gases. Figs. 29 to 32 are diagram drawings of a two-cycle engine, in which 1 represents the combustion chamber; 2, the piston; 3, the connecting rod; 4, the crank; 5, the crank case, which in the two-cycle engine must be air tight; 6, the gas inlet opening in the crank case; 7, the inlet port; 8, the exhaust port; 9, the spark plug; 10, deflector to prevent direct exit of gas out of the exhaust port.

In the operation of the engine, suppose the engine is running and the crank case and combustion chamber are full of gas. The piston is at its highest point and the spark plug ignites the gas in the combustion chamber, when the position of the piston occupies the position shown in Fig. 29. The expansion of the burning gases forces the piston down, and a non-return valve on the inlet opening, 6, prevents the gas in the crank case from escaping. Before the piston reaches its lowest point, it uncovers the exhaust port and allows the burnt gases to partially escape, as shown in Fig. 30. A moment later, the inlet port is uncovered and a fresh charge is admitted from the crank case, which is forced up by the pressure in the crank case, and which forces out the burnt charges, Fig. 31. Before any of the new charge of gas can escape through the exhaust pipe, the piston has begun its next upward stroke and covers the exhaust port. The upward stroke is continued, Fig. 32, compressing the charge above, and by the suction created in the air-tight crank case, it draws in a new charge of gas through the inlet opening, 6. The upward stroke being completed, the charge is compressed and ignited and the "cycle" is complete. Following the sequence of events, it will be seen that the "cycle" is completed every revolution, or every two strokes, and therefore is called a two-stroke, or more commonly, a "two-cycle" engine.

The two-cycle engine gives an impulse or working stroke every revolution, the momentum of the fly-wheel being depended upon to carry the piston up on the idle or compressed stroke. The deflector, 10, on the top of the piston, is used to deflect the gas upwards and prevent its rushing directly across the cylinder and out at the exhaust port. The relative size and position of the inlet and exhaust ports are the most important consideration in designing a two-cycle engine.

The four-cycle engine is shown in Figs, 33 to 36, in which 7 is the inlet valve and 8 is the exhaust valve. the other parts being the same as in a two-cycle engine, with the exception that the crank case need not be air-tight. The valves are actuated by cams driven by the crank shaft. Supposing that the piston it as the top of the stroke and traveling downward. Fig. 33, the inlet valve is open and the suction draws in a charge of fresh gas. On the next up-stroke, Fig. 34, both inlet and exhaust valves are closed and the gas above the piston is compressed. When the piston reaches the top of its stroke, the compressed gas is ignited, and it expands, driving the piston down and furnishing the working stroke, Fig. 35. On the next up-stroke, Fig. 36, the exhaust valve opens and the burnt gases are forced out by the piston. The cylinder is now clear, ready for a fresh charge. This cycle is completed in two revolutions or four strokes, and known as a "four-cycle" engine. There are three idle strokes and one working stroke for each complete cycle.

In comparing the two types, the two-cycle engine has the advantage of extreme simplicity, as it has no valves or complicated moving parts. It imparts a working impulse each revolution, hence more power may be obtained from the same size engine, than is possible from a four-cycle engine; but not twice as much, as would seem to be the case, because the superior regulation of the four-cycle engine gives more perfect consumption of gas. The more frequent impulse of the two-cycle type produces a smooth running engine, gives less vibration and requires a lighter fly-wheel.

The action of the gases in the cylinder of the two-cycle engine is more or less uncertain. It is possible that some of the

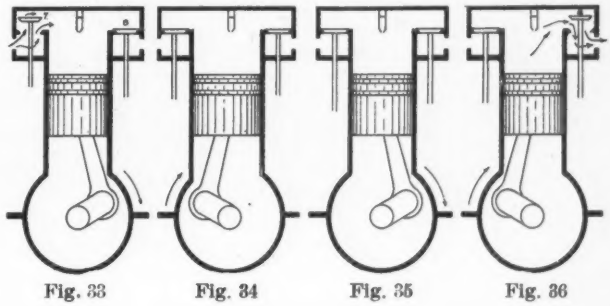


Fig. 33 Fig. 34 Fig. 35 Fig. 36

exhaust gases will not escape, or that some of the fresh charge may escape through the exhaust. Driving out the burnt gas by the fresh charge, while some combustion may still be going on, sometimes results in the ignition of the fresh charge, which extends to the crank case and produces what is known as a back explosion. Any wear in the crank-shaft bearings will cause a loss of crank-case pressure and consequent loss of power. Any leak around the piston will allow the partially

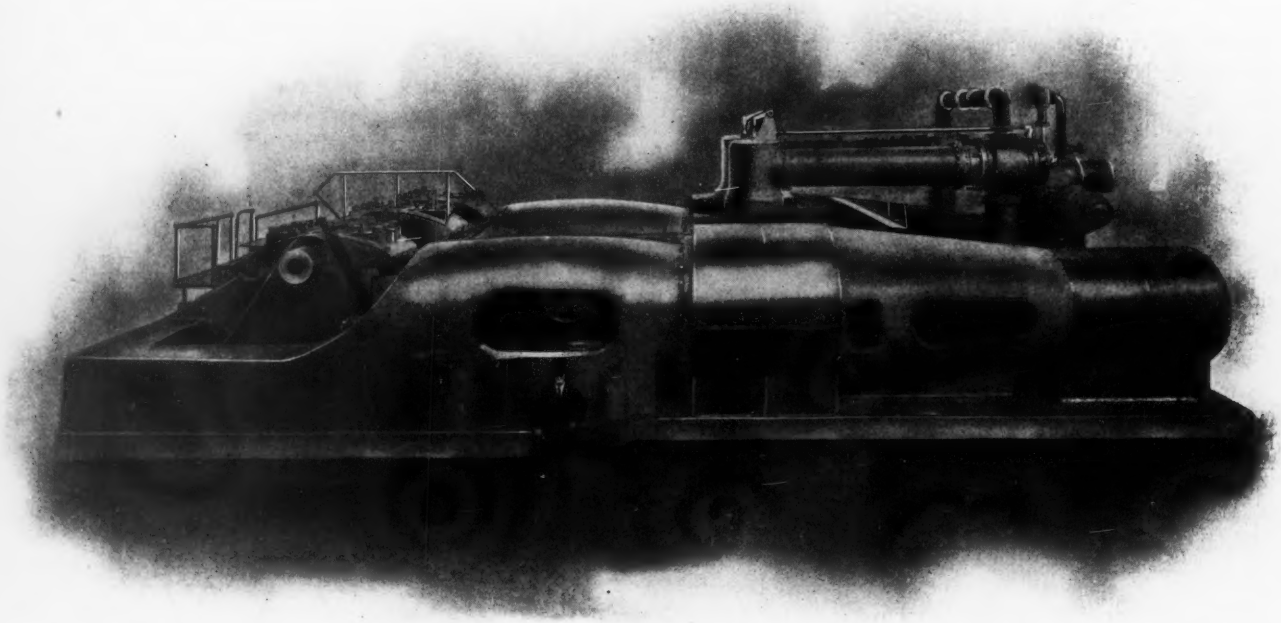
burned gases to pass down and deteriorate the quality of fresh gas in the crank-case.

The four-cycle engine, although more complicated, is more certain in its action. The gas is under perfect control. The idle stroke allows the cylinder more time to cool between explosions. The fresh charge enters during one complete stroke instead of in a "puff," as in the two-cycle engine. The four-cycle may be run at a higher number of revolutions. Because of mechanical regulation, there is less chance for loss of gas and economy is therefore greater.

As a rule, for small, light engines, where economy in gas is not important and for engines receiving little or no care, the two-cycle type is the better. Where economy of fuel and greater reliability is a consideration, the four-cycle engine will give more satisfaction.

The Largest Steam Engine.

The largest steam engine ever installed in any plant is being erected at Sharon, Pa., for the Carnegie Steel Company, by the Allis-Chalmers Co. The engine, as a whole, without foundation plates or flywheel, weighs 550 tons. It is a horizontal, twin-tandem rolling mill engine, with cylinders 42 in. and 70 in. x 54 in. stroke, designed to operate condensing at 175 lbs. steam pressure and a speed of 150 to 200 r. p. m., developing its maximum power at the highest number of revolutions. Being used to operate the rolls in a steel mill, it has to be quickly reversed at the end of each run, and the load varies within a few moments from nothing to the maximum power exerted. The reversing mechanism used for changing the direction of the engine is of the Reynolds-Marshall type, and run by a small independent engine with oil cylinder lock. Another small engine is also employed in operating the steam throttle valves, all of these units being under perfect control of the one engineer. Only a few seconds are needed for the act of reversing.



THE LARGEST STEAM ENGINE IN THE WORLD
25,000 H. P. Horizontal Twin Tandem Compound Rolling Mill Engine to be installed at Carnegie Steel Co., Sharon, Pa.

Michigan Peat Fields.

The district surrounding Ann Arbor, Mich., abounds for many miles with peat deposits, which will undoubtedly be utilized in the future, as the sources of other kinds of fuels are more and more depleted. Besides being used for a fuel, gas and coke, with various by-products, may be made from peat and it has been converted into paper and other fabrics. As a fuel, peat must be dried and put into portable form and many methods have been devised for accomplishing these ends. The material may be used locally, however, without such careful preparation, by adopting the simple methods of the European peasants, who cut from the deposits blocks of fairly uniform size, stack them up in such a way that they dry during the summer, and then store them under cover. The fuel value of good peat is about three-fifths that of coal, weight for weight, but it is probably a more efficient fuel than this ratio would indicate, as a considerable part of coal is rejected with the ash and clinkers, while peat is almost wholly burned. It is estimated that a single acre of peat 1 foot in depth will furnish from 150 to 200 tons of dry fuel and that this amount is present for every foot in depth to which the peat extends. In a number of counties in Michigan the surface area of peat is large and some of the deposits are known to be 70 feet deep, while many of them are at least 20 feet in depth.

NEW MASSACHUSETTS BOILER RULES

Rules of Construction and Installation Which Go Into Effect May 1, 1908

The Board of Boiler Rules of the State of Massachusetts have recently issued a new set of boiler rules which will apply to all boilers installed in that State after May 1, 1908. These rules give the chemical and physical properties that will be required of open-hearth boiler plate and rivet steel, method of testing, kind of material to be used in shells and drums, details of construction and installation, and were devised by Joseph H. McNeill, Chief Inspector Boiler Department; John A. Stevens, representing boiler-using interests; Frederic H. Keyes, representing boiler-manufacturing interests; Robert J. Dunkle, representing boiler insurance interests, and William M. Beck, representing the operating engineers.

The following rules relating to the installation of boilers, which will particularly interest the engineer, are as follows:

1. The boiler builder's stamp shall not be covered by insulating or other material.

2. The maximum pressure allowed on a shell or drum of a boiler shall be based on a factor of safety of not less than five (5).

3. The longitudinal joints of a boiler, the shell or drum of which exceeds thirty-six (36) inches in diameter, shall be of butt and double strap construction.

4. The longitudinal joints of a boiler, the shell or drum of which does not exceed thirty-six (36) inches in diameter, may be of lap-riveted construction; and the maximum pressure allowed on such shells or drums shall not exceed one hundred (100) pounds per square inch.

5. Any form of longitudinal joint other than specified in paragraphs Nos. 3 and 4 of this section shall be submitted to this board for approval.

6. The longitudinal joints of horizontal return tubular boilers shall be located above the fire line of the setting.

7. A horizontal return tubular, vertical tubular or locomotive type boiler shall not have a continuous longitudinal joint over twelve (12) feet in length.

8. The thickness of plates in a shell or drum shall be of the same gauge.

9. The minimum thickness of plates used in the construction of a boiler shall be one-fourth (¼) inch.

10. The minimum thickness of shell plate shall be as follows:

	When the Diameter of Shell is—		
36" or Under.	Over 36" to 54" inclusive.	Over 54" to 72" inclusive.	Over 72".
Not less than ¼"	Not less than 5-16"	Not less than ⅜"	Not less than ½"

11. Butt straps shall be rolled to the proper curvature on forms made for that purpose.

12. The thickness of butt straps shall be in proper proportion to the thickness of the shell plates, and in no case shall they be less than five-sixteenths (5-16) inch in thickness.

13. The minimum thickness of heads and tube sheets of horizontal return tubular and vertical fire tube boilers shall be as follows:

When the Diameter of Boiler is—				
42" or Under.	Over 42" to 54" inclusive.	Over 54" to 72" inclusive.	Over 72" to 78" inclusive.	Over 78" to 84" inclusive.
⅜	7-16"	½"	9-16"	⅝"

14. In no case shall the thickness of heads and tube sheets of horizontal return tubular and vertical fire tube boilers be less than the thickness of the shell plates.

15. The thickness of plate in stayed flat surface construction shall not be less than five-sixteenths (5-16) inch.

16. Rivet holes shall be drilled full size in place or punched at least one-fourth (¼) inch less than full size. When the holes are punched they shall then be drilled to full size, with plates, butt straps and heads bolted up in position, after which the plates shall be separated and all burrs removed.

17. Rivets shall be of sufficient length to completely fill the rivet holes and form a head equal in strength to the body of the rivet.

18. Rivets shall be machine driven, wherever possible, with sufficient pressure to fill the rivet holes, and shall be allowed to cool and shrink under pressure.

19. The shearing strength of steel rivets shall be as specified in paragraph No. 4, section 1, of these rules.

20. Tube holes shall be drilled full size, or the centre punched out not to exceed one (1) inch in diameter and finished up full size with a rotating cutter.

21. The edges of tube holes shall be chamfered to a radius of about one-sixteenth (1-16) inch.

22. The calking edges of plates and heads shall be beveled wherever possible. Calking shall be done with a round-nosed tool.

23. Openings in shells, drums or heads, for pipe connections over one and one-quarter (1¼) inches in diameter, except feed-pipe connections where a brass bushing or its equivalent shall be used, shall be re-enforced with a standard commercial pressed steel flange, or with a steel plate the thickness of which shall be not less than the thickness of the shell plate. Main steam and safety valve openings may be fitted with cast steel or cast iron nozzles.

24. The standard manhole opening shall be an ellipse eleven by fifteen (11 x 15) inches.

25. There shall be a standard sized manhole in the upper part of the shell or head of a fire tube boiler over thirty-six (36) inches in diameter, except vertical fire tube boilers.

26. A manhole frame shall be of wrought or cast steel, and have a net cross-sectional area, on a line parallel to the axis of the shell, not less than the cross-sectional area of shell plate removed on the same line.

27. The strength of manhole plates, yokes and bolts shall be in proportion to the strength of the manhole frames.

28. Manhole plates shall be of wrought or cast steel.

29. Manhole frames on shells or drums shall have the proper curvature, and on boilers over forty-eight (48) inches in diameter shall be double-riveted to the shell or drum.

30. The standard handhole shall be an ellipse of the following sizes:

Two and one-fourth by three and one-fourth (2¼ x 3¼), inches.

Three by four and one-half (3 x 4½) inches.

Four by six (4 x 6) inches.

31. A standard sized manhole shall be located in the front head, below the tubes, of a horizontal return tubular boiler sixty (60) inches or over in diameter.

32. A standard sized manhole or handhole shall be located in the front head, below the tubes, of a horizontal return tubular boiler less than sixty (60) inches in diameter.

33. A standard sized handhole shall be located in the rear head of a horizontal return tubular boiler, except one which has a standard sized manhole in the front head, below the tubes.

34. A locomotive type boiler shall not have less than six (6) standard sized handholes, located as follows:

One in the rear head below the tubes.

One in the front head at or about the line of the crown sheet.

Four in the lower part of the water leg.

35. A vertical fire tube boiler, except the boiler of a steam fire engine, shall have not less than three (3) standard sized handholes, located as follows:

One in the shell at or about the line of the crown sheet.

Two in the shell at the lower part of the water leg.

36. A vertical fire tube boiler of a steam fire engine shall not have less than three (3) brass washout plugs of not less than one (1) inch pipe size, screwed into the shell and located as follows:

One at or about the line of the crown sheet.

Two at the lower part of the water leg.

37. There shall not be less than one and one-half (1½) inches of solid plate around a handhole opening in a shell or drum of a boiler.

38. The maximum size of a surface blow-off pipe shall not exceed one and one-half (1½) inches, and it shall be carried through the shell or head with a brass boiler bushing.

39. A bottom blow-off pipe shall be fitted with a valve or cock; the minimum size of pipe and fittings shall be one (1) inch and the maximum size shall not exceed two and one-half (2½) inches. Globe valves shall not be used.

40. When the pressure allowed on a boiler exceeds twenty-five (25) pounds per square inch, the bottom blow-off pipe and fittings, from the boiler to the valve or valves, shall be extra heavy.

41. When the pressure allowed on a boiler exceeds one hundred and thirty-five (135) pounds per square inch, the bottom blow-off pipe shall have two (2) valves, or a valve and a cock; and such valves, or valve and cock, shall be extra heavy.

42. When a bottom blow-off pipe is exposed to the products of combustion, it shall be protected by a substantial cast iron removable sleeve or equivalent covering of non-conducting material.

43. An opening in brickwork for a blow-off pipe shall be fitted with an ample cast or wrought iron sleeve, to provide for free expansion and contraction.

44. A bottom blow-off cock shall have the plug held in place by a guard or gland. The end of the plug shall be distinctly marked in line with its passage, and a handle shall be securely attached to the plug in line with the mark on the end of the plug.

45. All stop valves two (2) inches and over in diameter shall be of the outside screw and yoke type.

46. When boilers on which the allowable pressure exceeds one hundred and thirty-five (135) pounds are set in battery, the main steam pipe shall have two (2) stop valves of the outside screw and yoke type, with an ample valved drain between them having an open discharge. The pipe and fittings, up to and including the valves, shall be extra heavy, made to the manufacturers' standard for high pressure.

47. The feed pipe of a boiler shall be of brass from the check valve to the discharge end, and shall have open end or ends.

48. When boilers of fifty (50) horsepower or over are set in battery each boiler shall have two (2) stop valves, or a stop valve and stop cock, on the feed pipe, one on each side of the check valve.

49. The feed water shall discharge about three-fifths (3-5) the length of a horizontal return tubular boiler from the front head, and at or about the central rows of tubes above the upper row, when the diameter of the boiler exceeds thirty-six (36) inches and the pressure allowed exceeds twenty-five (25) pounds per square inch. The feed pipe shall be carried through the head or shell with a brass boiler bushing, and securely fastened inside the shell above the tubes.

50. When a boiler of over fifty (50) horse-power has a pump, inspirator or injector as the primary means of supplying feed water when the maximum pressure allowed is carried, more than one such mechanical appliance shall be provided.

51. The temperature of the usual feed water entering a boiler shall not be less than 120 degrees Fahrenheit when the pressure allowed exceeds twenty-five (25) pounds per square inch.

52. Feed water shall not discharge in a boiler in close proximity to riveted joints in shell or furnace sheets.

53. The minimum size of pipes connecting the water column of a boiler shall be one (1) inch.

54. No connections, except for damper regulator, drains or steam gauges, shall be placed on the pipes connecting the water column to the boiler.

55. When shut-off valves are placed on the pipes connecting a water column to a boiler, these valves shall be of the straight-way outside screw and yoke type, and shall be locked or sealed *open*.

56. No water glass shall have automatic shut-off valves.

57. The water connection to the water column of a boiler shall be of brass when the allowable pressure exceeds twenty-five (25) pounds per square inch.

58. The steam connection to the water column of a horizontal return tubular boiler shall be taken from the top of shell or the upper part of head; the water connection shall be taken from a point not less than six (6) inches below the center line of the shell.

59. A horizontal return tubular boiler over seventy-eight

(78) inches in diameter shall be supported from steel lugs by the outside suspended type of setting; where three (3) supports are necessary on each side of a boiler an equalizer shall be used.

60. A horizontal return tubular boiler over fifty-four (54) inches in diameter, and up to and including seventy-eight (78) inches in diameter, shall be supported by the outside suspended type of setting, or by not less than four (4) steel or cast iron brackets on each side, set in pairs.

61. A horizontal return tubular boiler up to and including fifty-four (54) inches in diameter shall be supported by the outside suspended type of setting, or by not less than two (2) steel or cast iron brackets on each side.

62. Supporting lugs or brackets shall have the proper curvature and be securely riveted to the shell.

63. When it is necessary to place a fusible plug in a tube, an extra thick tube shall be provided for that purpose.

64. Water leg and door frame rings of internally fired boilers thirty-six (36) inches or over in diameter, shall be of wrought iron or wrought steel.

65. The upper surface of the fire-grate of an internally fired boiler of the open bottom locomotive, vertical fire tube or similar type shall not be less than two (2) inches above the row of rivets at the lower end of the furnace.

66. Wet bottom boilers shall have a clear space of not less than twelve (12) inches between the bottom of the boiler and the floor line.

67. A fire-tube boiler shall have the ends of the tubes substantially beaded.

68. The ends of all tubes, suspension tubes and nipples shall be flared not les than on-eighth (⅛) inch over the diameter of the tube hole on all water tube boilers and superheaters.

69. The ends of all tubes, suspension tubes and nipples of water tube boilers and superheaters shall not project through the tube sheets or headers less than one-fourth (¼) inch nor more than one-half (½) inch. Separately fired superheaters shall have the tube ends protected by refractory material where they connect with drums or headers.

70. Cross pipes connecting the steam and water drums of water tube boilers and cross boxes shall be of wrought or cast steel when the working pressure exceeds one hundred and sixty (160) pounds per square inch.

71. Provision shall be made for the expansion and contraction of steam mains connected to all boilers, with substantial anchorage at suitable points, that there may be no perceptible vibration on the boiler shell plates.

72. Steam reservoirs shall be used on steam mains when heavy pulsations of the steam currents cause vibration on the boiler shell plates.

73. When boilers have their safety valves set at different pressures, and are connected to a common steam main, the boilers allowed the lowest pressure shall each be protected by a safety valve or valves placed on the connecting pipe to the steam main. The area or combined area of the safety valves shall not be less than the area of the connecting pipe.

74. Pressure parts of superheaters, attached to boilers or separately fired, shall be of wrought or cast steel when the working pressure exceeds fifty (50) pounds per square inch.

75. Boiler and superheater mountings, such as nozzles, cross pipes, steam pipes, fittings, valves and their bonnets, shall be of wrought or cast steel when exposed to steam which is superheated over 80 degrees Fahrenheit.

76. When a superheater can be shut off from a boiler, whether attached or separately fired, it shall have an ample safety valve at or near the steam inlet.

77. All boilers set in battery and superheating the steam they generate over 80 degrees Fahrenheit, shall have two (2) top valves, with an ample valved drain between them having an open discharge.

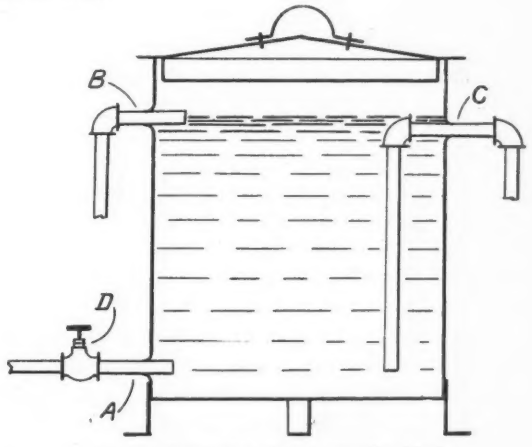
78. All superheaters shall be fitted with drains from headers or drums where water of condensation can collect.

79. All boiler shops in which boilers are constructed for installation in this commonwealth shall be open to the members of the boiler inspection department of the district police and inspectors holding certificates of competency as inspectors of steam boilers, as provided by section 6, chapter 465, Acts of 1907, at all reasonable hours, for inspection of material, methods of manufacture, workmanship and testing.

This board does not recommend the use of externally fired boilers over eighty-four (84) inches in diameter.

An Easily Made Oil Separator.

The accompanying illustration is that of an efficient and easily made oil separator, for separating the oil from the water before filtering.



An Oil Separator that is Easily Made

A gallon oil can or an ordinary waste can may be used for the tank and the pipe, A, is connected to the drip from the engine and fitted with a small valve, D. The oil and water from the engine enter through this pipe until it is on a level with the pipe B. The oil floating on the surface of the water passes off through the pipe B, while the water runs out through C, which is one-quarter inch lower than B, so that the water cannot reach B. To prevent any oil from getting into pipe C, when starting the separator, enough water should be poured into the can to cover the bottom of pipe C.

A short rule for finding the temperature of the steam when the gauge pressure is known is as follows:

Take the square root of the gauge pressure, multiply it by 14 and add 199. The result will be the temperature of the steam.

THE SELECTION OF COAL

Impurities in Coal and Their Effect Upon the Boiler Efficiency

At a recent meeting of the New England Street Railway Club, Mr. E. G. Bailey, Chief of the coal testing department of A. D. Little's Laboratory, presented a paper entitled, "The Selection of Coal," which contains some interesting facts about the mining of coal, how it should be selected and the effect of impurities upon the boiler efficiency. In the paper, Mr. Baker says that the coals used in New England come chiefly from the 2100 mines in Pennsylvania, Maryland and West Virginia, which ship bituminous and semi-bituminous coal, the New England States receiving about ten per cent. of the output.

After giving an interesting description of the methods of mining and the reasons why coal, even from the same mine, does not run uniformly, Mr.Bailey said: "The buying of the coal is up to you, gentlemen. There are many different methods employed to-day and some of them are somewhat antiquated. Some people buy coal simply because the price is the cheapest they have had quoted to them. Another man buys coal upon its past reputation. He thinks, 'That coal has always given good results; it gives Mr. So-and-so good results and I will keep on buying it.' Another takes the recommendation of his engineer or fireman, and no matter what the price, he says, 'That coal is worth the money and I will take it.' Another man buys his coal upon the basis of the highest number of heat units per dollar. Another will make evaporative tests and buy the coal giving the highest evaporation per dollar. Of course the latter result is what every one wants in a steam plant, but in such cases the purchaser is frequently misled, because he figures the price of his coal F. O. B. the car or vessel and does not consider that a coal which may evaporate eight pounds of water to a pound of coal costs a good deal more to handle than if the coal evaporated 10½ pounds of water to a pound of coal. He has to pay more for labor for having the coal brought into his boiler-room; he has more ashes, and all the way through there are numerous small expenses which, if considered in the first place, might show that coal to be more expensive at the end of the year than the other coal would have been. In any case, you cannot depend entirely upon the price and quality, whether you take it from heat units or evaporation. There are certain practical things that must be considered, such as delivery and the question of spontaneous combustion. There are numerous things upon which you cannot put a definite money value, and each person must use his own judgment, to a certain extent, after all. He must determine the coal to buy, either from a trial, or from past use of that particular coal.

"The method of determining the quality of coal by evaporative tests is what may be considered the really practical method, but there are certain difficulties even there. The boiler efficiency varies with so many things that it is practically impossible to maintain the same boiler conditions throughout two consecutive tests. The fireman has a great deal to do with it; the load on your boiler, the draft, the cleanliness of the heating surface; all these things are very irregular. The method of determining heat units in a laboratory is a very practical one. A small amount of coal is taken, which is a representative sample if properly taken, and is burned in an atmosphere of oxygen in a steel bomb which is submerged in water. A very delicate thermometer gives the temperature of this water before the coal is burned, and by means of an electric spark the coal is ignited and entirely burned and every bit of the heat developed is absorbed by the water and the thermometer rises accordingly. From this rise in temperature the B. t. u. are determined. The result is practical, as a B. t. u. is the heat required to raise the temperature of one pound of water one degree Fahrenheit. It obviates all the errors which come in a practical boiler test.

"In every boiler room, the thing of primary importance is to keep steam regardless of efficiency, if you are going to keep your cars moving. But in designing a plant or making changes, efficiency should be considered as well as the ability to keep steam. There are certain conditions where the boiler capacity is limited, the grate area is small, and the draft is not very strong, so that only the very best of coal can be burned. In such cases they must confine themselves to Pocahontas, New River, or Georges Creek coal, regardless of the price. But if the quality of coal coming into a market be sufficiently different and there is such a difference in price that the cheaper coal would be a great saving at the end of the year, it will pay almost anyone to make decided changes in their boiler plant. if necessary, in order to take advantage of the coal which will give them the most evaporation per dollar. Many people consider the cost of a plant of primary importance, but the fuel bill will eat up the price of a new plant practically every year, so that it only takes a difference of a few per cent. in waste, as far as boiler efficiency is concerned, to repay anybody for taking very decided steps in improving boiler conditions so they will be able to burn the cheapest fuel.

"Although you do have your plant designed so you can handle the very poorest grade of coal coming into the market, there are certain conditions entering which may prevent you from getting as high efficiency as from the best coal. One of these is moisture. The higher the moisture in the coal, the less efficiency, because that moisture must be evaporated before the water in the boiler can be. This is of very little importance, except in cases of 'crop' coal, such as I spoke of a while ago, except when you travel further West. As you go through Ohio and Illinois, where the coal runs very high in moisture, this item is of considerable importance, as compared with the Eastern coals. The high volatile gives a chance for loss when burned under ordinary conditions. A furnace can be designed so that all of this is burned and little or no loss results from it. Take a boiler which gave good efficiency with anthracite coal and put a gas coal of 35 per cent. volatile in that furnace, and you will have a decided loss, because your hydro-carbons are cooled before they can become completely burned. It takes a longer time to mix those gases with the air, and if the temperature is reduced before that mixture is complete, your flame is extinguished and loss results. The Chicago Edison Company has met this problem very successfully. The Illinois coal which they burn is high in ash and

sulphur, and has many difficulties along the mechanical line to be considered. The volatile matter is very high and the question of unburned gases and smoke has been a considerable annoyance, not only to them, but to other people in that district. They have now a furnace in which they have an abnormally large combustion chamber, and claim that there is practically no smoke. I have seen their stack several times and have never seen smoke coming from it.

Ash in coal is also a matter which affects the boiler efficiency. This depends not altogether upon the amount of ash, but upon the nature of it. Ash from certain coals has a very high fusing temperature. It is almost impossible to make any large clinker from it, no matter how much fire you have, while other coals at a comparatively low temperature (the fire not being forced) will give a very bad clinker. This has frequently been blamed on the sulphur. The sulphur itself should not take the blame, because it is a question of the fusibility of the ash. Tar will melt at one temperature, pitch at another, lead at another, and iron at another, depending upon the fusion points of those different compounds or elements. Ash in coal is a good deal the same. It is composed of practically the same things as clay. You take an ordinary paving brick and line your furnace with it, and it doesn't last very long, but the best of fire clay will withstand a very intense heat. The ash in coal can be compared almost directly to the clay of which brick is made. Some of it contains considerable iron and other fluxes, which cause it to melt at a very low temperature and gives a great deal of trouble in burning grates, stopping the air supply, necessitating frequent cleaning of the fire, which condition cannot help but result in a lower boiler efficiency. Every time you clean the fire you lose several per cent. Your boiler is cooled and in order to obtain the previous furnace conditions, several hundred pounds of coal are required. Also, with a higher ash, whether clinking or not, the fire must be cleaned more frequently, and the percentage of loss in the coke that drops through your grate is larger in proportion to the working of the fire and the number of times that it is cleaned. Mr. Abbott made some tests not long ago in which he showed with the same coal that as the ash was increased to 40 per cent. the boiler efficiency was reduced to zero. The United States Geological Survey made some tests at St. Louis, in which they burned some of the refuse resulting from the washing of coal. I do not have the exact figures at hand, but the ash in that refuse ran 50 odd per cent. and the boiler efficiency obtained was above 40 per cent.

Sulphur in coal is detrimental for two reasons. It is generally combined with iron, and the iron causes the clinker. The sulphur also, being liberated as the coal is burned, undoubtedly has some effect on the boiler tubes, the stack (if an iron stack is used) and the other iron work, but just to what extent this occurs I have no specific data. In a case to my knowledge, where horizontal return tubular boilers are used at mines which produce coal varying from 0.9 to 4.00 sulphur, there was no practical difference noted in the condition of the boilers. In another case, where low sulphur coal was burned, an analysis of soot and other accumulation on the outside of the tubes of a B. & W. boiler showed nearly 25 per cent. of free sulphuric acid and sulphates of iron, showing that the tubes had been attacked more or less by the sulphur.

The boiler efficiency may often be greatly increased by the method of firing. The fireman has a great deal to do with the coal bill, especially as to keeping conditions uniform in the furnace. The mechanical stoker has done this in many cases to a great extent, but the man with the shovel can approach it, oftentimes, a great deal closer than he does, especially with a high volatile coal. As quick as the coal is thrown on the red-hot bed of fuel, gases immediately begin to be given off, and in a gas coal, at the end of five minutes, there would be 33 per cent. of the heat of that coal given off, whether there is any air present or not. This determination was made by tests showing the loss in caloric value of coal after it had been on a bed of fuel for different lengths of time. With semi-bituminous coals this is much more uniform, and the gas is given off slower. There is not so much of it; the carbon remains until the air comes in contact with it. So that the fireman with the one-shovel method can save several per cent. over the man who piles fuel in regardless of anything else except his own desire to hurry up and get through with it and sit down as long as he can. The air supply should at all times be proportioned to the requirements of the coal. This is very important and the best way to approximate this result is by the use of the damper regulator. The losses which a fireman is accountable for are either unburned gases or excess air. With a thin fire or a fire with holes and too much draft, the amount of air passing through the fire is very great, sometimes causing a loss of 20 to 30 per cent.

The gas analysis in the boiler room is of much importance and the CO_2 machines that are now on the market are undoubtedly well worth their cost, if they were only perfected beyond the point of being an instrument. They are oftentimes found to be so delicate that the least thing will put them out of operation, and in some of the larger plants it has been found necessary to have a man detailed to look after those instruments alone. Otherwise they will give erroneous results, and as quick as the fireman has found that they can err he loses his confidence in them, and says, "If it is wrong once, it is wrong again. I know my fire is better than what it indicates."

Another very important item is the question of cleanliness of the heating surface. The tubes are not blown sufficiently often in some plants; the scale is not kept out of the inside. An accumulation of this will cause a high flue temperature and considerable loss. Yesterday where there was a 225 horsepower boiler running at about 60 per cent. of its rated capacity, the fuel temperature was 624. This was very high for that type of boiler running at that rate. The tubes were scraped at noon. During the afternoon the load, which was very uniform throughout the twenty-four hours, was practically unchanged and the temperature during the afternoon was 370. This would mean several per cent. if there had been a very large air excess, but the gas analyzed about 14 per cent. CO_2 so that the air excess was very low, but even in this case of extremely low air excess the saving in efficiency of that boiler after the tubes were scraped was over 6 per cent.

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100 Years of Anthracite.

The centennial anniversary of the use of anthracite coal, which was held on February 11th, has opened up some interesting incidents in the early uses of the "hard black stones," as the pieces of anthracite were called in the early part of the nineteenth century. Before the year 1808 anthracite coal was considered of little use because it would not burn except under forced draft. It remained for Judge Jesse Fell, of Wilkes-Barre, Pa., to prove that it could be used successfully. This he did by building two walls of brick in an ordinary fireplace, in the centre of which he arranged some iron bars for the grate and front, very similar to the open grates now in use. He obtained a hot fire by this method, thus showing its adaptability as a fuel, and its use soon extended throughout the anthracite coal region.

Up until that time bituminous coal was the only kind used, and the users of it were accustomed to see it blaze up the moment it was thrown on the fire, and because anthracite would not do this it was thought that it was not a fuel, and because the more it was raked and poked—an operation that was found necessary with bituminous coal—the worse it would burn. Its first use for industrial purposes is said to have been in a rolling mill near Philadelphia, where it was used to heat the iron ingots. Having heard of its wonderful heating properties, Josiah White, the owner of the mill, decided to give it a trial, but for a considerable time each trial was a failure. It was about to be abandoned, because the mill hands were sick and tired of it, when one day they shoveled a large quantity of the hard coal into the furnace, shut the doors, and left the mill. By accident one of the men returned to the mill some time afterward and discovered a tremendous fire in the furnace, the doors red with heat. This demonstrated what before had not been known, and that was that it took time to ignite the hard coal, and it was used exclusively in that mill thereafter.

It was a number of years after this even before any extended use was made of it, however, owing to the fact that many persons thought it dangerous and workingmen were prejudiced against it because of the changes in firing involved, but when the advantages of its use became properly known, an almost unparalleled boom started over the hard-coal country.

Its use, particularly under boilers, grew rapidly after the steam engine came into more general use, but to-day, owing to the high price for which it is sold and the limited area over which it is found, the use of anthracite for power purposes is on the wane, although the year 1907 broke all records for anthracite coal production, the increase being due to the prosperous times and its more extended use for domestic purposes.

Many people there were who laughed at Judge Fell in his efforts to burn what was supposed to be an inflammable substance, but to-day the hard-coal industry employs about 180,000 men and boys, producing nearly 80,000,000 tons of coal annually, the retail price of which is close to $320,000,000.

While the use of the anthracite may be said to have had a rocky career in its early days, there are many other things equally important which are slumbering for want of proper

exploitation and whose path will be equally as thorny when they are first tried. Peat may be said to be one of these despised substances, but the day may not be far off when the peat fields will bring to their owners as much, if not more, wealth than was brought to the anthracite regions by the early pioneer who first proved that hard coal could be burned, and whose memory is enshrined by the people of Wilkes-Barre, who have fittingly celebrated his first successful experiment 100 years ago.

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Not Yet But Soon.

Notwithstanding all the good things that were promised for the new forms of incandescent lamps during the past year, it must be said that the realization of these promises by the incandescent lamp manufacturer have been very disappointing. The tantalum lamp, which was one of the earliest lamps to attempt to break in upon the field occupied solely by the carbon incandescent lamp, has had, perhaps, the best success of any of the vacuum lamps, using the new rare elements. It gives a candle power on about two watts, but its life is not over six hundred hours. Nobody is exactly sure if it is applicable on alternating-current circuits or not. The life of tantalum lamps on alternating current varies greatly, depending on various conditions, and prospective users are advised to use a small number of lamps on their particular alternating-current circuits before using in large quantities.

The osmum lamp, for which so much was promised, has disappeared in the background, and the helion lamp is still too new to be thought of seriously, although preliminary tests have shown them to give a candle power on one watt of energy and their life to be comparable to the carbon lamp.

Of all the new types of lamps which have sprung into existence, the tungsten lamp seems to possess those qualities which will go to make up the successful high efficiency lamp, although, at the present time, a number of obstacles will have to be overcome, such as the breaking of filaments in shipment, and the lowering of the cost of manufacture. Up to the present time, these lamps have been made abroad, but it is said that American makers are about to turn out tungsten lamps which will make them available for every-day use, both in point of service and cost of the lamp.

The advent of a new efficient incandescent lamp has been awaited with very much patience, because a successful lamp of this kind will mean a greater amount of illumination per kilowatt of generating capacity, or a considerable saving of fuel for a given number of candle power. Their use will also mean a lowering of the cost of distributing mains for a given candle power, or if the same size mains are used per candle power of lights supplied, it will mean that there will be less drop of potential in them, owing to the smaller value of current passing through them.

In the langauge of the day, the commercial success of the new incandescent lamps may be said to be, "Not yet, but soon."

Monday Morning Explosions.

The following is a brief account of two accidents which happened on Monday morning, February 3d, and is only a sample of what happens in some plant in the United States on every Monday morning in the year, when the plant is started after a shut-down:

SUNBURY, PA., FEB. 3.—Seven men were killed and more than a dozen were injured by the explosion of a boiler to-day in the rolling mill of Van Allen & Company, at Northumberland, two miles north of here.

The rolling mill had been shut down for three months and was to have resumed work to-day. All the boilers and machinery had been overhauled during the suspension. The men were preparing to begin work, when from some cause not yet ascertained, one of the number of boilers blew up.

The whole bulding in which the boilers were located was wrecked, and the dead were found under the ruins. Those killed were residents of this place and are survived by large families. The loss to the plant is estimated at $75,000.

MONACA, PA., FEB. 3.—Three foreigners were killed and six others seriously injured to-day when the boilers in the Welch brick plant exploded. It is supposed frozen water pipes caused the accident. The damage is estimated at $7,000.

As will be remembered, less than three years ago the Brockton explosion, in which fifty-seven persons lost their lives, was a Monday-morning explosion, and in going over the newspaper accounts of boiler explosions each week it will be found that the Monday afternoon and Tuesday morning papers contain more than a majority of the whole number of explosions that happen during the week, excepting, of course, boilers in sawmills and threshing engine boilers, which seem to be blowing up at regular intervals every day throughout the year.

Since past records have proven that there is more danger involved in starting up a plant after a shut-down than in running it regularly, the engineer should be very particular on Monday morning to be sure that everything around the boiler room is absolutely in good working order. Anything which interrupts the regular operation of a plant and which changes the uniformity of conditions tends to produce additional strains on its parts, so that an explosion is more likely at those times than at any other. Consequently no engineer should take a chance in starting a plant or in cutting in a boiler which has gone through a period of idleness when he is not satisfied that all the safety devices, which are put on the boiler to prevent accident, will answer any call that will be made upon them.

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Proposed New Electrical Unit.

As there has never been an electrical unit adopted for the kilowatt-hour, it is proposed to use the name "kelvin" for it in honor of Lord Kelvin, the great electrical scientist, who died a short time ago. The kilowatt-hour, being a measure of practical electrical work, is one of the most frequently used of all electrical units and one with which the users of electrical energy are most familiar. Aside from honoring the man, the word "kelvin" is shorter and more euphonious than "kilowatt-hour." If it should be adopted by international agreement, it will only fall in line with precedent, which named the various units of current, resistance, voltage, capacity, inductance, reluctance, etc., after well-known men, whose labors in the electrical field deserved meritorious mention.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

Technical Books. Answers to Examination Questions.

EDITOR THE PRACTICAL ENGINEER:

In the December issue, I found a letter written by A. D. P. which I read with great interest. Regarding most engineering books written at the present time, I wish to say that I agree with him and I find that a man must be a college graduate in order to understand them. They are so full of mathematics and complicated formulae that none other but a technical man can read them. I do not wish to include all books, for there are a number which are good, but the majority of them are of little practical value. If engineers would take some good engineering paper and use "Letters from Engineers" column more than they do, they would find much of good practical value. One paper that is the best I have ever read is THE PRACTICAL ENGINEER. I think talks such as Mr. Kavanagh's are of great value to the engineer who has a limited education, as they are very easily understood.

In the same letter A. D. P. gives a number of questions asked him which I will try to answer so that he and other readers may understand them.

1. Why has a slide valve lap?

Outside lap is given to a valve so that it can cut off the steam and give it a chance to expand in the cylinder. The greater the outside lap, the earlier the cut-off and the greater the expansion. If the valve had no outside lap, there would be no cut-off and therefore no expansion; i. e., the engine would take steam for the entire stroke.

Inside lap gives an engine compression; that is, a small amount of the exhaust steam is retained in front of the piston due to the inside lap and as the piston completes its stroke, it is compressed to nearly the boiler pressure. This brings the piston gradually to rest, prevents pounding and fills the clearance spaces with steam so that it does not require so much fresh steam from the boiler each stroke.

2. If lap is added, what part of the valve gear must be changed?

If outside lap is added to the slide valve, it would be necessary to arrange the cut-off mechanism so that a longer travel could be had for the valve. Most likely a new eccentric would be necessary. The angle of advance would also have to be increased; that is, the eccentric would have to be advanced farther ahead of the crank. This is necessary in order to bring the outer edge of the valve in the same position it had at first, so that the steam ports would be uncovered at the same instant as formerly.

3. If the piston struck both heads, what would you do?

This may happen from a number of causes but I believe it to be very rare. Such a thing could happen if the babbitt was melted out of the main bearing, or if the connections had been allowed to wear to a great extent, or if the arrangements for taking up wear on the reciprocating parts may have become loose. If a new crank has been fitted it may be too long. This should have been discovered while it is being put in place, however. In each case the cause suggests its own remedy. It would be advisable, when the engineer heard the piston strike the head, to stop the engine. This would undoubtedly answer the examiner's question.

4. Is oil good for boilers? Why not?

Oil in steam boilers is supposed to be harmful for the reason that where it settles on the plates there is danger from overheating of the plates which will cause pockets to form. These pockets, if not discovered in time, will become so thin from the stretching of the plate that the pressure in the boiler is too great for the weakened material and an explosion is liable to result.

5. What is the angle of advance?

The eccentric of an engine with no lap or lead is set at an angle of 90 degrees ahead of the crank. If lap is added and lead given to the valve, the eccentric must be moved ahead of its former position; that is, it must be advanced more than 90 degrees ahead of the crank. This is necessary in order to bring the edge of the valve to the edge of the steam port. The angle beyond 90 degrees, which the eccentric is ahead of the crank, is called the angle of advance.

6. If you could not stop new piston packing from leaking, what would you do?

I would have the cylinder rebored and the rings properly fitted. Perhaps it would only be necessary to set out the rings.

7. If the suction valves leaked in a duplex pump, would the cylinder drips look after the leakage?

No. They are not made for that purpose.

8. How would you give more lead to a slide valve engine?

By moving the eccentric farther ahead on the shaft.

9. What is the effect of small port openings?

The steam cannot follow the moving piston fast enough, causing wire-drawing of the steam.

Shawano, Wis. P. E C.

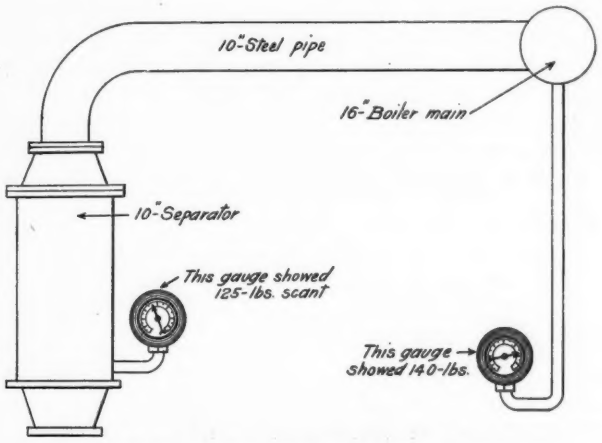
The Efficiency of Steam Separators.

EDITOR THE PRACTICAL ENGINEER:

In answer to F. L. T.'s question as to the efficiency of a steam separator, it is claimed by makers of steam separators that the per cent. saving is equal to the per cent. of moisture in the steam delivered to it. This statement is based upon results of tests which show that the initial condensation due to moisture in the steam causes a loss equal to the per cent. of moisture in the steam. Therefore, if the separator removes the moisture and thus saves the initial condensation from this cause, the per cent. saving will be equal to the loss due to the initial condensation or the per cent. of moisture removed. It would seem from the above that the efficiency or saving would be dependent on the quality of the steam.

There is another thing that must be considered and that

is, how does the separator affect the steam pressure? I recently connected a gauge between the separator and throttle and found that while the pressure showed 125 pounds there, the gauge on the boiler header showed 140 pounds.



Does Drop in Pressure Affect Efficiency of Separator

The connections were made as shown in sketch. This seems to show a reduction of about 15 pounds due to the throttling or chopping action of the separator. Considering the drop in pressure, does this not affect the efficiency of a steam separator?

Fairport Harbor, O. E. S. H.

Short Cuts Often Not Advisable.

EDITOR THE PRACTICAL ENGINEER:

In regard to the friendly comment which appeared in January issue, concerning my pump problem in the December issue, I would say that I fully intended to treat the problem in an analytical and step-by-step manner, because I believed that way to be the best for beginners and those who wish to get at the root of the problem. Short cuts are desirable only *after* all that should be known about a subject has been absorbed; but if my method is advanced as too lenghty, as thought by our friends J. H. C. and E. S. H., it seems to me that E. S. H.'s method is too short as shown in his concluding expression.

$$P = \frac{33{,}000}{15 \times 1.7671} = 12{,}453 \text{ pounds.}$$

I suppose E. S. H. worked it out like this:

$$P = \frac{33{,}000 \times 5}{0.5 \times 15 \times 1.7671} = 12{,}453 \text{ pounds.}$$

but to those who do not quite understand transposition methods, it may not be clear just how he can get 12,453 pounds, when according to the *exact* statement, without allowing for any mental arithmetic, the result will be 1245.3 pounds which varies considerably with the correct answer known to E. S. H. I simply call attention to the foregoing in the same spirit in which the criticisms of my method were made.

Scranton, Pa. CHAS. J. MASON.

That Elusive Vacuum.

EDITOR THE PRACTICAL ENGINEER:

I notice in the January issue that E. W. K., of Cripple Creek, Col., gives an explanation of where the vacuum is formed in a working injector. He has perhaps a wrong idea of what I meant to convey in my former letter. I am willing to admit that in a lifting injector there must be a vacuum formed in order to permit the atmospheric pressure to force the water up into the injector, but after the water once reaches the injector I claim that the water completely fills the space where the vacuum was. What is there to hinder it from doing so? They tell us a vacuum is a space with nothing in it and water is a fluid having power to fill that space. Now why should the water fill part of that space that was a vacuum and still leave part of it as a vacuum? I also fail to see why E. W. K. has moved the vacuum down around the delivery tube. The vacuum, supposing there is any, would be around the suction tube. Of course, after the water begins to flow into the injector, the steam strikes it and, becoming condensed, it gives its velocity to the water, which it joins as fast as it is condensed. Now this naturally takes the water to the delivery tube, and the weight of the water plus the momentum acquired from the steam it has condensed forces it into the boiler. If the water is too hot, it will not condense the steam, and, therefore, it will not have the necessary velocity to allow it to enter the boiler, and it escapes through the overflow. Some engineers say that the water is too hot, which breaks the vacuum, but I think the above explanation is the proper one.

After the injector is working, the steam continually strikes the water and by condensation it gives it the necessary velocity which allows the atmospheric pressure to push the water up the suction tube and keeps the injector full Thus we always have a struggle going on in the injector between the steam trying to force all the water from the injector and the atmosphere forcing the water into it as fast as there is any room for it. So where does the vacuum come in?

Groton, Mass. C. J. W.

How to Prove Injector Contains Vacuum.

EDITOR THE PRACTICAL ENGINEER:

Referring to injectors having vacuum, E. W. K. is correct, but he does not give a way in which this can be demonstrated to the unbeliever.

Every injector has a vacuum around the suction tube, the word vacuum here meaning "a pressure lower than that of the atmosphere surrounding the machine." By taking an ordinary automatic injector, connecting up the steam pipe with suction open and turning on the steam, reduced pressure can be determined by placing the hand over the suction; if too hot, play a small stream of water on it while experimenting, and a considerable suction will be felt. This demonstrates the reduced air pressure, called vacuum, when the injector is not filled with water. Now connect up the suction and start the injector to working. If a small piece of waste or string be placed under the overflow valve, the injector will work if the overflow is not open too much and the discharge is not connected to boiler. By placing the fleshy part of the hand against bottom of overflow the hand

will apparently be drawn in, which is caused by the air on the outside having greater pressure than on the inside. This is a good thing to test even when an injector is working, as it will always determine a leaky overflow and will sometimes locate trouble.

A test of the suction connection will show that steam and suction tubes are working sufficiently to lift the water, and whether they are filled with scale or not. To test the suction pipe after it is connected plug up overflow or block valve with a piece of wood, put a valve or cap on end of suction pipe after it is connected, plug up overflow or block valve with a piece of wood, put a valve or cap on end of suction pipe, open suction valve and turn on steam. Any leak will show, and should be made tight.

Cincinnati, O. CHAS. A. DAVIS.

Low Pressure for Injector.

EDITOR THE PRACTICAL ENGINEER:

Regarding the letter of W. S. on the working of an injector under low pressure, I will say that 20 lbs. of steam pressure is enough to form a partial vacuum in the injector and that it will work at that pressure, especially in a non-lifting injector. I once had an injector that worked well at 18 lbs. pressure, and worked even when the steam dropped as low as 15 pounds. It was in the winter, and the water was 33 degrees, which is coldest water available.

Louisville, Ky. G. A. J.

EDITOR THE PRACTICAL ENGINEER:

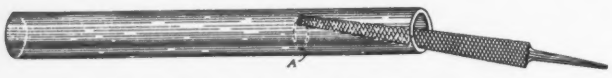
In regards to an injector working on 20 pounds of steam, I think I can beat W. S.'s record of working an injector on low pressure. Where I am employed we have an injector that draws water from a brook 270 feet distant on a 19-foot lift, and I can lift and force it direct into the boilers with 40 pounds of steam, or I can, by opening and closing two valves in the suction line, change the suction from the brook to a tank in the boiler room, which has about 4-foot lift, and I can start the injector on 20 pounds and work it down as low as 12 pounds.

North Haverhill, N. H. E. H. L.

Putting in Gauge Glasses.

EDITOR THE PRACTICAL ENGINEER:

An annoying thing which happens constantly in some plants is the breaking of a water glass. When this occurs the lower valve should be closed first, as water will scald



Method of Cutting Gauge Glasses

quicker than steam. Until a new glass is put in, the water level must be ascertained by the gauge cocks. Extra glasses should always be kept on hand, cut to the right length, and wrapped in cotton wool to prevent injury.

A good method to cut a glass is to hold the mark where the glass is to be cut to an emery stone. Where this is not practical a round file placed in the glass and slowly turned, the end of the file touching the line A where the glass is to be cut, as shown in illustration, will do the work.

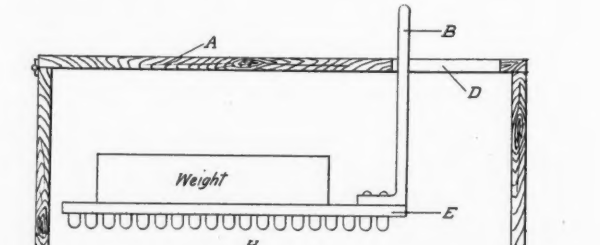
By all means be careful not to lay the glasses near old iron, as this allows them to become charged with electricity and they will likely break as soon as the water strikes them. Another cause of the glasses breaking is due to the diameter of the glass being the same as the packing nut, when it should be smaller to allow for the expansion of the glass when hot. If the gasket nut is not in line, the strain on the glass will sometimes break it. Pieces of the old glass in the nut will also crack the new glass.

Leominister, Mass. A. D. P.

Another Home-Made Overall Washer.

EDITOR THE PRACTICAL ENGINEER:

In the December number I noticed the description of an overall washer in connection with which I want to tell your readers about one that I consider to be better and much more easily made.



A Home-Made Overall Washer

The washer is a square or oblong box with a hinged cover, A. A board the full width of the box, but six inches shorter than the length is shown at E. On the bottom of this as well as on the bottom of the box, half round pieces of wood are nailed. A handle B is fastened to the movable board E, as shown and extends through an oblong hole 6 or 8 inches long in the lid at D. The steam-pipe which admits the steam is shown at C.

The overals should be put in the washer at H and allowed to soak over night and in the morning the dirty water can be emptied at K. Then fill up with clean water, turn on very little steam place a heavy weight on top of E and shut the lid. Now pull the handle B back and forth for a few minutes and you will find you will have good clean clothes, after rinsing in clean water. Of course, soap, or soda and soap, will have to be put in the washer with water.

Toronto, Can. H. B.

Blow-Off Valves.

EDITOR THE PRACTICAL ENGINEER:

I notice in your letter column an item about blow-off valves which is very good, the advice being needed, as there are many plants where the blow-off valves are leaking. I endorse what E. S. H. says about using two valves. I am using an asbestos-packed cock and angle valve on boiler, and they keep blow-off pipe cool, although they have been in constant use for six years.

I think it very important to have some good, service-

able device for blowing-off; if there is not, the engineer is likely to avoid blowing down a boiler as often as necessary in order to save the blow-off valve. Use some good type of valve, so that the attendant need not be afraid to use it. Several times I have replaced blow-off valves without emptying the boiler, and very often this saves valuable time and expense, especially if the boiler must be filled with cold water and everything kept waiting until you get up steam. To do this let steam down in boiler until no pressure shows, close all connections to the boiler tight, then put some cold water into boiler, which will cause a vacuum sufficient to retain the water while the valve is being replaced on blow-off pipe.

Indiana, Pa. D. A. F.

The Design of Counter Shafts

EDITOR THE PRACTICAL ENGINEER:

A short time ago, a foreman in our shop put up a line of shafting to run a room with 7 sewing-machines, to operate which would not require 3 horse-power. Being ignorant of any rule to figure the strain or load on the shafting between hangers, he put up a 1 7/16" shaft with hangers 7 feet apart, and he used 5 turns of 1-inch rope, which would be sufficient to run half the factory. He put the rope wheel, two clutches, and a pulley and belt from a donkey-engine, used to run at night, between two hangers. The shaft, after running 30 days, melted out the babbitt from the hanger-boxes. He then put up an extra hanger but it was too late, as the jerk of the rope and torsional strain broke it off in the center of the rope wheel. Then he put up a 1 15/16" shaft and more hangers, but it was rather an expensive experience.

As there may be a number of others who do not know how to find the working load and strain on shafting, the proper distance between hangers, and the pull per inch of single and double belts, I will illustrate how these may be found. Fig. 1 shows a counter-shaft that I erected in a shop which has given good results. Pulleys C and D are keyed tight on the shaft, and A and B are loose pulleys. Pulley C weighs 30 pounds and pulley A, B and D weigh 110 pounds. In making the calculations, take the left hanger as the center of moment

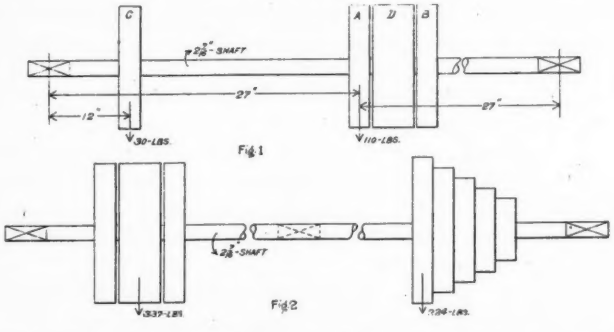


Fig 1

Fig 2

and we have $30 \times 12 \div 27 = 13\ 1/3$, and taking the right hanger as the center of moment we have $110 \times 18 \div 27 = 73\ 1/3$ pounds. Since the pull of single belts is 70 pounds per inch of width and that of double belts 100 pounds per inch of width, and as 6" double belt is used, the pull due to the belt is 600 pounds. Finding the moment of the load we have $600 \times 12 = 7{,}200 \div 27 = 266$, so that the downward pull on the belt will be $266 + 73\ 1/3 + 13\ 1/3 = 352\ 2/3$ pounds.

The pull at pulley D, in a horizontal direction, is $6 \times 100 = 600$ pounds, which would give $600 \times 18 \div 27 = 400$ popnds at the hanger. The resultant of the horizontal pull and downward pull will be $\sqrt{352^2 + 400^2} = 530$ pounds approximately. If a 2 7/16" shaft is selected, it will be found from the formula

$$l = \sqrt[3]{4{,}100{,}000 \times d^4 \div P}$$

in which l is the length between hangers in inches, d is the diameter of the shaft in inches and P is the load in pounds. From this formula, $l = 65$ inches, which is the maximum distance between hangers.

There are sometimes places where the shafts must be of extreme length in order to reach a machine and allow a pulley to drive it on the line-shaft, as shown in Fig. 2. The shaft is 76" long. When putting up a shaft of this kind, a center hanger should be used to avoid accidents. The down loads in this case are 820 pounds and the horizontal pull 360, the resultant of which is 895 pounds. By using the above formula we find that for a 2 7/16" shaft, the distance between center of bearings should be 55". S. J. K.

Orange, N. J.

Sticks up for the Steam Engine.

EDITOR THE PRACTICAL ENGINEER:

It was with a great deal of interest and profit that I read the article entitled "Enormous Power Consumed in our Industries," which appeared in last month's PRACTICAL ENGINEER. It seem to me that a few facts, such as these ought to be brought to the notice of some engineers.

In this mechanical age in which we live, the production of power and its attendant cost, is a question much discussed. Many are the arguments used for and against steam as a motive power. The other day I was conversing with an engineer, one who has no earthly use for books, and we got talking about power, and he began talking about suction gas producers and such like, and in his argument he got a little bit mad when I stuck up for the steam engine. "Why, boy" he says, "in five years steam will be out of existence." I took the opportunity to tell him that steam would not be out of business in his time or mine either. He was all gas producer and I guess I was all steam engine. Anyhow I asked him what such factories and mills, as were engaged in wood working and the like, would do with their waste products. I also asked him how he would heat the buildings that now depended upon the exhaust steam from the engines for heating, and why it was that many large power houses being built all over the world were installing steam engines. He argued about the operating cost of the two forms of power. It may be that gas producers and so on may be operated more cheaply than steam engines, but I asked him to look at the first great cost of installing them as compared with that of the steam engine. Besides, these things are new yet, and though they are making rapid strides in the way of perfection, they have not the long record behind them that the old reciprocating engine has. It has always been found reliable and "right on the job" every time, and with all the new and tried appliances and specialties in the market to-day, the danger attending steam has been greatly reduced and a fair degree of economy has also been attaind in its use.

My conversation with this engineer occurred a few days before I received my PRACTICAL ENGINEER. I intend to take advantage of the first opportunity to show him the article on the production of power and see what he says. I think that a man who is a stationary engineer, as he is, ought to be willing to stick up for the steam side of the question, and bring forth all his arguments in favor of it, and not be grumbling and growling and calling it down all the time. It looks to me too much like going back on his profession, whereas he ought to hold it up as one of the best under the sun.

I would like to hear the opinion of some brother engineers on this subject. Bring out all the points for and against each side. I know that any engineer whose heart is in his professiion will back up the old steam engine, but let us get at both sides.

In conclusion I would say that from the forceful facts shown in the article in last month's magazine, and from circumstances existing in every place where steam is used, and from its many advantages, that it will be a long time (if ever, which I doubt) before steam will take a back seat.

H. H. F.

Elimville, Ontario, Canada.

Solid End Plungers Better.

EDITOR THE PRACTICAL ENGINEER:

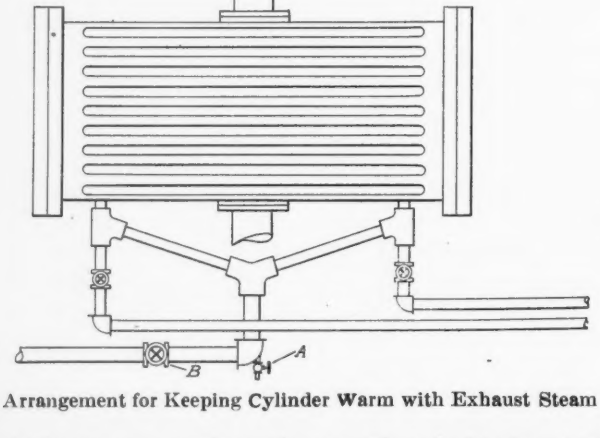
In regard to the article of J. C. H., "Will Open-End Pump Plungers Work as Well as Solid-End Plungers?" I think J. C. H. is right, as the open-end plunger will collect air and form a cushion, and if he should have to draw water with this pump he would have a great amount of trouble to make it work at all.

Lisbon, O. F. E. A.

Exhaust Steam Used for Keeping Cylinder Warm.

EDITOR THE PRACTICAL ENGINEER:

At a plant where I once worked, there was an engine which stood in an exposed place. The cylinder always had



Arrangement for Keeping Cylinder Warm with Exhaust Steam

to be kept warm, as the engine sometimes had to be started up in a big hurry. The engineer did not believe in having the cylinder drips connected, as shown by F. J. D. in the December number, but connected the cylinder as shown in sketch. B is a branch pipe from the exhaust pipe of an engine in another building. Live steam could be turned into this pipe when necessary, but it was seldom necessary, as the exhaust always kept the cylinder nice and warm. In the winter, we used to leave the small drip A open, and thus none of the water of condensation went into the cylinder from the pipe B.

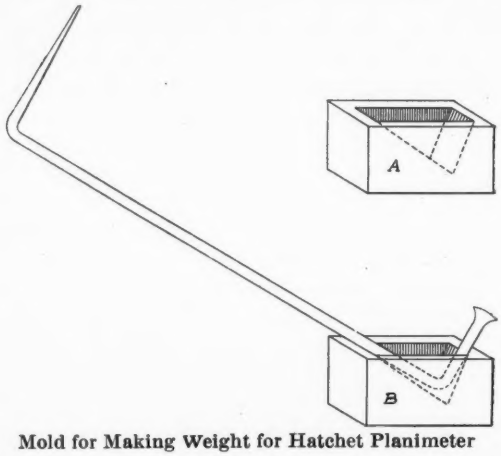
Toronto, Can. H. B.

Weight for Hatchet Planimeter.

EDITOR THE PRACTICAL ENGINEER:

I read with much interest the article "Experience With the Hatchet Planimeter" in the February issue, and would suggest the following method for making a neat and serviceable weight for hatchet planimeters:

Make a mold of either clay or plaster of paris, as shown at A, of proper depth and length. A mold 2½ inches long,



Mold for Making Weight for Hatchet Planimeter

½ inch wide and 1 inch deep will be about right and just large enough to allow for finishing. Care should be taken that the mold is perfectly dry before the metal is poured. The planimeter may then be placed in the mold, as shown at B, and the babbit poured. When the metal is cool it may be trimmed and polished, making a very neat-appearing instrument and one that may easily be made by any engineer.

Trenton, N. J. H. H. Y.

Recent Mass. Examination Questions.

EDITOR THE PRACTICAL ENGINEER:

If engineers are interested in examination questions, here are a few which were asked by the new Massachusetts inspectors:

How can you tell that a piston is not centered without removing cylinder head?

If a tube in feed-water heater burst and water passed into the exhaust pipe of engine, what would you do?

How would you remove a solid-end connecting rod?

On what part of an engine gear does the reversal of a steam elevator act?

How is the crown bar in a locomotive boiler supported?

What is the range of cut-off in a riding cut-off engine?

What is clearance, as applied to boxes?

Why should metallic packing not be used in the valve-stem stuffing box of an automatic cut-off engine?

Leominister, Mass. A. D. P.

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

A New Type of Battery Wanted.

EDITOR THE PRACTICAL ENGINEER:

I would appreciate it very much if some one would give me directions for making a battery that can be used in place of the primary battery for ringing bells. At present, I am using eight wet cells in series, three wires being used between engine room and four other stations, the length of circuit being about 1600 feet. The cells give considerable trouble to keep them charged, so I would like to make some other kind of battery, if the cost is low.

Trenton, N. J. H. H. Y.

Method of Using Hatchet Planimeter.

EDITOR THE PRACTICAL ENGINEER:

I have read, with interest, Mr. C. N. Lewis' article on experience with the hatchet planimeter, and I have made one as near like it as I could. I used a piece of No. 4 copper wire and a round block of babbitt for a weight. I bored a hole through the weight and put on the wire before bending. I also drew a 4-inch square diagram to test it, and I got the planimeter to give the exact area; that is, if I traced it the proper way.

I would like to ask Mr. Lewis why the hatchet is placed to the right of the center and how far, and in what direction should the tracing point take? In testing the planimeter for correction, I drew a straight line about 2 feet long and adjusted the planimeter so that it would follow the line the whole length. I took a piece of smooth drawing-paper about 8 x 14 inches and drew a line down the center, then placed the card at the top and fastened with thumb-tacks, with the center of the card about ⅛-inch to the left of the center line, then started my hatchet from the center line, thus only having to make one mark with the hatchet. It certainly is an interesting instrument, and if made carefully, it will be very accurate.

Elyria, O. J. C. H.

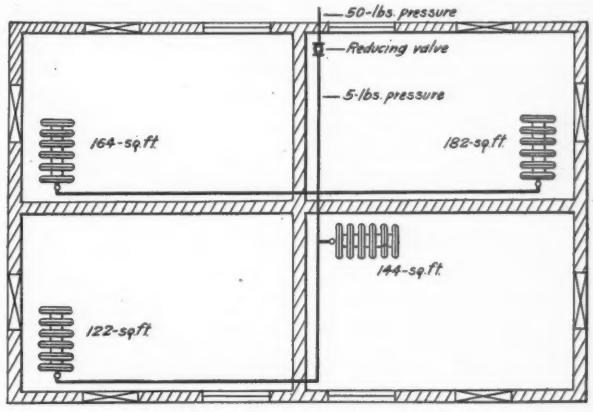
The following answer is given by Mr. C. N. Lewis, to whom the question was referred:

"The hatchet of the planimeter is placed to the right of the center simply because it travels to the left in passing around the diagram, like the hands of a watch. The planimeter should travel the same distance in passing either way around diagram; if it does not, the planimeter is not right. The trouble will be in its working edge, there being a little more bevel on one side than on the other. Correct until travel is equal. I would suggest to J. C. H. that he discard his copper planimeter and make one out of ⅜-in. steel wire. Make it nice and true and then invite other to beat you in the accuracy of their work is they can."

Design of Heating System.

EDITOR THE PRACTICAL ENGINEER:

I am going to heat a small building by steam, and I would like some information in regard to the size pipe I must use. Steam at 50 pounds pressure will be brought into the building and reduced to 5 pounds through a reducing valve. The system of piping will be the one-pipe relief system, and the water of condensation will be taken care of by a trap. What I want to know is what size reducing valve to use and what shall be the size of the main pipe and its branches for the low-pressure steam. The accompanying sketch shows



Size of Pipe Required for Heating System

the arrangement of the piping, each being marked with the number of square feet it is to supply, the total amount of radiating surface being 612 square feet.

Newburyport, Mass. J. T. M.

The rules generally used by careful designers of heating systems are as follows:

1. Find the number of heat units one square foot of heating surface gives out ($1.8 \times 150 = 270$ heat units) and multiply this by the number of square feet of radiating surface, to get the total number of heat units required.

2. Divide the number of heat units required by the heat units in one pound (966), and the result will be the number of pounds of steam required.

3. As there are 26.4 cubic feet in one pound of steam, multiply the number of pounds required by 26.4 and the result will be the number of cubic feet of steam required per hour.

4. Since in steam heating it is usual to allow 50 feet per second as the flow of steam, or 180,000 feet per hour, the area of the pipe in square feet can be found by dividing the cubic feet of steam required per hour by 180,000.

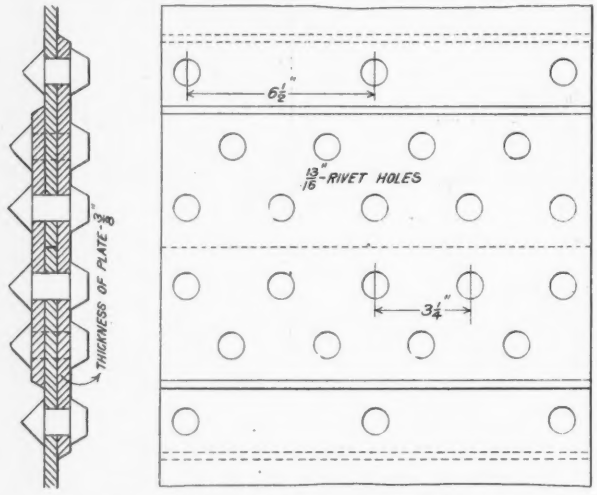
In the given problem, to find the area of main pipe, multiply 612 by 270, which = 165,240 heat units. Dividing by 966, gives 171 pounds of steam required, and multiplying this by 26.4, which gives $171 \times 26.4 = 4514.4$ cubic feet required. The area of the pipe in square feet will then be $4514.4 \div 180{,}000 = .025$, or $.025 \times 144 = 3.6$ square inches. As it is to be a single-pipe system, allow 50 per

cent. more than the above, in which the area of the main pipe should be 5.4 square inches. The nearest size pipe to this valve is a 2½-inch pipe, so that this sized main and reducing valve should be used. According to the same rule, it is found that the diameter of the branch pipes should be 1½-inch diameter, except that branch which must supply 122 square feet, which may be made 1¼-inch diameter.

Efficiency of a Triple-Riveted, Double-Strap Butt-Joint Stay Bolts for Curved Surfaces

EDITOR THE PRACTICAL ENGINEER:

Will you kindly show me the simplest method of working out the following problem: Taking rivets at 38,000 pounds per square inch, single shear, and 70,00 pounds, double shear, give rule and method of analysis for finding the efficiency of a butt-seam double-strapped joint having two rows of rivets



Triple-Riveted Double-Strap Butt-Joint

in double shear and one row in double pitch, single shear. Tensile strength of plate 60,000 pounds, thickness of plate ⅜", thickness of straps 5/16", rivet holes 13/16", single pitch 3¼", double pitch 6½".

Will you also work out for me what size stay-bolts and what pitch should be used for a circular firebox, 36" diameter, 5/16" sheet, pressure 100 pounds.

Seattle, Washington. J. H. P.

The strength of a double-strapped butt joint, triple-riveted, may be calculated as follows:

Thickness of plate, ⅜" = .375 inches.

Diameter of rivet-hole, 13/16" = .8125 inches.

Area of rivet-hole = .5185 square inches.

Pitch of rivets, 6½" = 6.5 inches.

The strength of the whole plate would be $6.5 \times .375 \times 60{,}000 = 146{,}250$ pounds.

The strength of net section of plate at outer row of rivets = $(6.5 - .8125) \times .375 \times 60{,}000 = 127{,}968$ pounds.

The strength of one rivet in single shear	= 38,000
Four rivets in double sheer is $4 \times 70{,}000$	= 280,000
Total shearing resistance	318,000

From these figures it can be seen that the shearing resistance is greater than the strength of the net section of the plate. Therefore using the ratio of the strength of the net section of the plate to the strength of the plate, the efficiency becomes

$$\frac{127{,}968 \times 100}{146{,}250} = 87.5 \text{ per cent.}$$

In working out the number of stays for curved surfaces, the Hartford Steam Boiler Inspection and Insurance Company recommend that stay-bolts for curved surfaces should be calculated the same as for flat surfaces, according to Clark's formula, which is as follows:

$$S = 5700\, t \div p,$$

in which t is the thickness of the plate, p is the steam-pressure and S is the pitch of stays. In the given case

$$S = 5700 \times .3125 \div 100 = 17.8".$$

and the diameter of the stay-bolt can be obtained from the formula

$$D = .0064\ S \sqrt{p},$$

in which D is the diameter of stay-bolt, S is the pitch of bolts and p is the pressure in pounds per square inch, or

$$D = .00064 \times 17.8 \times \sqrt{100} = 1.139",$$

or about 1¼ inches diameter.

Duplex Pumps Less Economical Than Single Pumps.

EDITOR THE PRACTICAL ENGINEER:

In reference to R. W. P.'s question about the economy of single and duplex pumps, there are two reasons why duplex pumps are more extravagant in the use of steam over single pumps. First, because of the wasted clearance of steam in the cylinder, whose piston is not travelling its full stroke, and second, because duplex pumps have double the number of ports, and steam spent in filling ports is steam wasted.

New Bedford, Mass. B. A. L.

Stones in Pumps Caused Shutdown.

The plant of the Beacon Electric Light Company, of Chester, Pa., was compelled to completely shut down on the afternoon of February 17th, owing to the pumps becoming clogged with stones, which the suction pumps drew with such force from the river that the screen through which the water passes was broken, allowing the stones to pass through. As a result of the electric current being shut off, a number of industrial plants which depended upon the electric light plant for light and power were compelled to shut down. The afternoon newspaper was unable to issue its edition until late in the afternoon, and several matinee performances were discontinued, owing to insufficient illumination.

A New Principle in Grate Bars as Applied in the Heath Reciprocating Grate.

The advantage of keeping the fire door closed, except when coaling, and the increased efficiency of the furnace due to a clean fire have brought the shaking grate into extensive use for the economical combustion of all grades of fuels. To be thoroughly practical, however, a shaking grate must be very simple in construction, and durable under hard usage. The grate which fulfills these conditions and which involves a new principle, the result of twenty years' expe-

rience, is the Heath Reciprocating Grate, shown in the accompanying illustration.

The device consists of a series of corrugated grooved top grate bars and headers supported on a frame work placed four inches below the surface of the grates, being made to

The Heath Reciprocating Grate Bar

shake or reciprocate alternatively in opposite directions, one end of each bar being supported on nearly frictionless bearings. This movement is a sifting instead of a rocking or crushing movement.

The fuel-supporting surface of the new grate being entirely corrugated, not only provides for contraction and expansion, insuring durability, but provides a large percentage of air space with small openings, thereby producing good combustion with a minimum loss of fuel. The grooved tops of the grates and headers serve several purposes: The top of the bars are protected from burning by accumulating a deposit of the finer ashes in the grooves and preventing clinkers from burning on to the top of the bars, thereby preventing burning off the top of bars; the grooves provide a rough surface, which, as the bars reciprocate, rakes the bottom of the fire, making a cleaning motion without excessive waste; the grooves being filled with fine ashes, there is presented less surface to exposure to the fire, thereby providing for durability. All parts of the grates are put together loosely to prevent warping and twisting, and there are no bolts, pins and fittings to burn out, rust or break. All parts are reversible, interchangeable and practically fool-proof.

The grates can be installed without any change in the fire box and without cutting the boiler front. The Heath Grate Bar Co., 10 Oliver Street, Boston, Mass., are the manufacturers.

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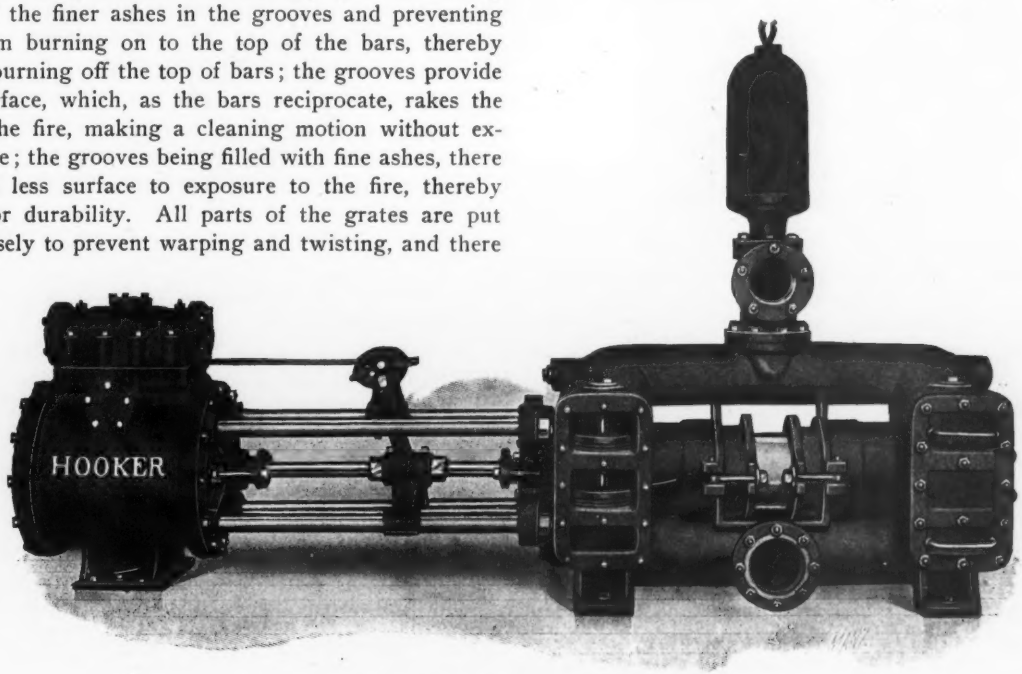
The Hooker Outside Packed Plunger Pump.

The accompanying cut shows a simple and efficient outside-packed plunger pump made up in several patterns for high-duty boiler feeding and heavy-pressure mine service. This pump has been designed to combine simplicity with durability and is constructed on lines that insure great strength in all its parts which are subjected to strains and pressure. The water valve chambers are conveniently arranged and easily accessible by means of openings on the side. Not only can the valves be quickly examined and replaced, but there is ample room to reach beneath and clean out under the suction valves.

The steam-valve movement is of extreme simplicity, the gearing having few parts. It is designed with roller bearing and is adjustable by means of set screws. The main steam valve is flat-faced, which allows it to wear to a fit.

The plungers work through the middle exterior stuffing boxes in separate and distinct water cylinders, and as the surface of the plungers is exposed they can be kept lubricated. Any leakage is detected and remedied by adjusting the stuffing box glands. The valve areas and waterways are large in proportion to the plunger displacement, so that the velocity of the water and the consequent destructive action of water currents is greatly decreased.

The pumps are fitted with bronze valve seats, with either bronze or rubber valves. The removal of one hand-hole plate exposes both valves to view, and both valves are held in place by a heavy tobin bronze bolt, thus minimizing the danger of the valve stems breaking.



The Hooker Outside-Packed Plunger Pump

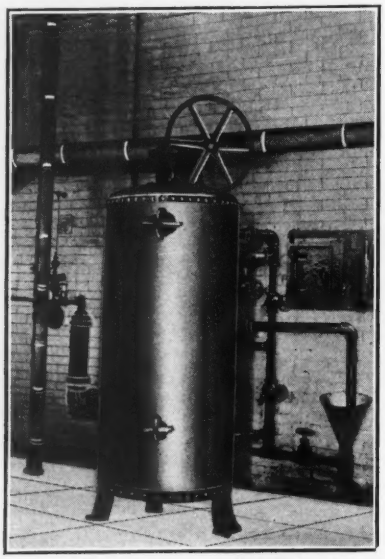
Being outside center-packed, the water end is durable, the only part subject to wear being the stuffing boxes. The

central arrangement does away with the possibility of the plunger sagging under heavy pressure. Ample room between the glands makes the stuffing boxes easily adjustable.

The Hooker steam pump is manufactured by the Hooker Steam Pump Company, 218 Granite Building, who also manufacture a complete line of pumping machinery and air compressors.

Keystone Filter Equipments for Small Plants.

One of the most efficient methods of preventing scale from forming in a boiler is to prevent the scale-forming ingredients in the water from entering the boiler, which may be done by filtering out the impurities in the feed water before it enters the boiler. A system which works on this principle is the Keystone Pressure Filtering Apparatus, which has had extensive use in this country. The treatment of the boiler feed water consists of precipitating the dissolved impurities as insoluble phosphates and then filtering them through a bed of especially prepared quartz.



Keystone Pressure Filter System at the Zahn & Bowley Plant, Rutherford, N. J.

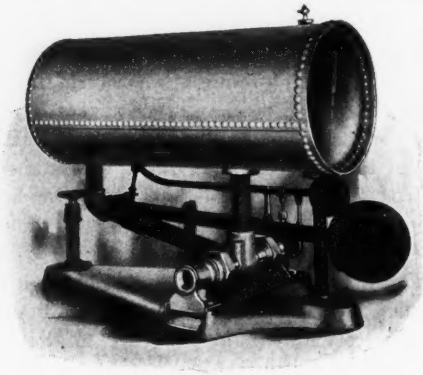
Water which may be perfectly clear and apparently perfectly pure has been found to contain as much as nine grains of carbonate of calcium and carbonate of magnesium per gallon. Filtering alone would not have removed these impurities, and it is only when they are precipitated through chemical treatment that removal is possible. As shown in the illustration, which shows an installation of a Keystone Pressure Filter System at the plan of the Zahn & Bowley Co., Rutherford, N. J., in connection with a 100-horsepower boiler, the apparatus is simple and compact, no settling tanks being required.

While the advantages of a filtering apparatus are well known, managers of small plants are often deterred from installing such a system, even when badly needed, because it is thought that the expense of installation would be greater than that warranted by the saving affected. In the 100-horsepower installation shown in cut the manufacturers claim that the saving more than justifies the cost of the apparatus. Before the installation the boiler tubes were incrustated to a thickness of five-eighths of an inch with a scale composed principally of carbonate of lime and magnesium. Experiments have shown that half-inch boiler scale necessitates the consumption of 60 per cent. more fuel than is required when the tubes are clean, and it is also well known that the increased temperature required to penetrate scale softens and shortens the life of boiler tubes. Taking into consideration only the waste of coal, however, it was found at the smallest calculation a saving of four dollars a day would be effected by keeping the tubes clean. Such a saving warrants easily an investment of $6000, and the Keystone Filter equipment did not cost anything approaching such a sum.

The Keystone Filter equipments are manufactured by the Keystone Chemical Manufacturing Company, of Philadelphia, Pa.

The Morehead Steam Trap.

Condensation is present in practically all steam systems whether adapted to heating or power purposes, and as the elimination of the condensation increases the efficiency of the steam, it should be removed from the steam and if possible returned to the boilers. To perform this operation a steam trap is generaly used which may or may not return



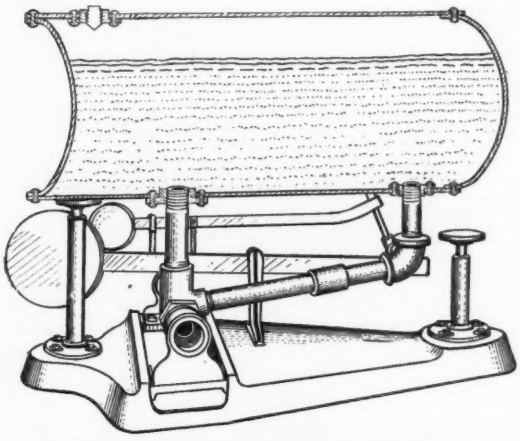
Morehead Non-Return Trap

the water of condensation to the boiler, depending upon the design of trap.

A type of trap which has had considerable use for these purposes is the Morehead Steam Trap, shown in the accompanying illustrations. The non-return traps are applicable to any service where the condensation is to be discharged into a tank, hot well or drain, and are adapted to the draining of all classes of steam coils, cylinder jackets, cooking apparatus, separators, compresed air lines and gas mains. The return traps are used in cases where the amount of condensation is such as to warrant its use as feed water.

The Morehead Trap consists of a steel tank, the heads and longitudinal seams of which are riveted and caulked. The tank swings on a brass trunnion between two supports secured to a cast iron bed plate. The supports consist of the valve connection on the one side and the water connection on the other. In the case of the non-return trap the water end serves as an intake to receive the condensation, while the valve end provides for the discharge. In the return trap the admission and discharge of the condensation takes place at the water end of the trunnion, while the valve end

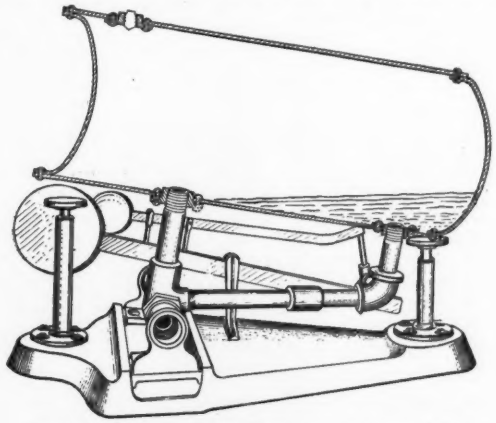
serves as an admission port for live steam. This valve, which has a removable disc, therefore serves as a steam admission for the return trap, and in the non-return trap it provides at the proper time a discharge for the contents of the trap.



Position of Trap at Beginning of Discharge

The tank is counter-balanced by a cast iron counterpoise weight on the end of a wrought iron lever. Leading from the valve casting of the return trap is a weighted automatic relief valve, operated by a link connection from the steam valve lever. In the non-return trap the air is relieved from the tank by the pet cock fitted in the top of the tank. Two upright buffers are used to limit the swing of and provide resting points for the trap in its filling and discharge positons. All valves and working parts are made of hard brass, and are accessible.

When returning the condensation to the boilers by means of the return trap the best results are obtained when the trap is located at four feet above the level in the boiler. The water from the condensing surfaces or lines of pipe is

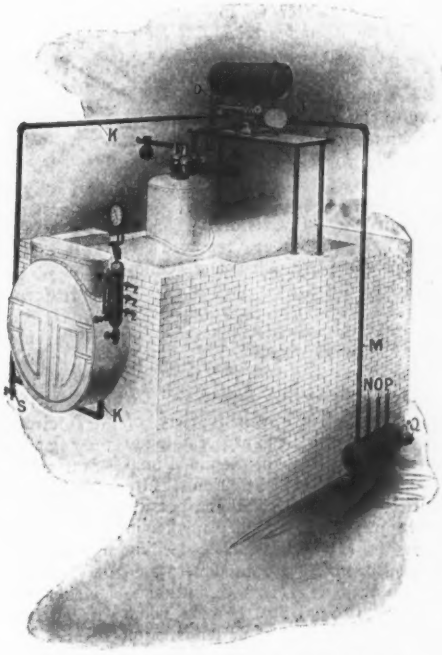


Position of Trap when Discharge is Completed

drained into a receiver, from whence it is forced by the pressure of steam through an auxiliary pipe leading from the receiver into the trap. It is especially applicable for feeding boilers from open heaters.

In dealing with pressure less than atmospheric pressure a return trap is necessary, because to force the water of condensation against the pressure of the atmosphere requires the use of live steam. This type is therefore applicable for removing condensation and entrained oil from exhaust pipes and receivers of compound engines, separators and other vacuum systems. When thus used the traps are connected to the lowest point of the system. The Morehead Trap is also used for raising water from one level to another and discharging it to a given point at any distance from the trap.

The operation of the return trap is as follows: The tank, supported by the brass trunnion, is maintained normally in a horizontal positon by means of a weighted lever. When sufficient water has entered the trap to overcome the action of this lever the tank tilts downward, automatically opening the live steam valve, admitting steam in the tank. The re-



Connection for a Single Return Trap

sulting equalization of the pressure in the trap and boiler permits the water to flow from the trap to the boiler. The air valve which relieves the trap of air pressure when the tank is filling is automatic in its operation.

The operation of the non-return trap differs from that of the steam trap, inasmuch that the pressure from the lines which are drained is always exerted on the water in the trap. As the trap tilts the discharge valve is opened and the contents of the tank is forced out by the line pressure.

The connection of the single return trap system is shown in the accompanying illustration. This arrangement is used when the pressure is sufficient to lift the condensation to the required height. When the pressure on the return is not sufficient to raise the condensation from the receiver to a trap above the boiler a double trap installation is used, the lower trap being placed below the receiver and the upper trap being located above the boiler, as shown.

The Morehead return traps and non-return traps are manufactured by The Morehead Mfg. Co., 1051 Grand River Avenue, Detroit, Mich.

TRADE NOTES

EDITED BY THE ADVERTISING MANAGER

The Geo. W. Lord Company, 2238 North 9th Street Philadelphia, publish a booklet, "For the Man Who Runs the Boilers That Run the Business." It is well written, instructive and full of "ginger." A copy may be had for the asking. Engineers who send a sample of scale may have it analyzed and receive an engraved certificate of analysis free.

The Cline Feed Water Heater Co., Lancaster, Pa., will send an illustrated circular descriptive of the Cline Heater to any one interested. This heater is comparatively new on the market, but has been in use for some two years or more and the results obtained from it as reported are most remarkable. It is exceptionally easy to clean and the manufacturers say that every time you clean it you have a new heater. Write for circular and investigate it.

Recent sales of the "Swartwout" Direct Flow Centrifugal Separators are reported by the Ohio Blower Company, Cleveland, Ohio, Company, Cadillac, Mich.; 1-6 inch to Garfield Worsted Mills, Passaic, N. J.; 2 to American Steel Foundries Company, Alliance, Ohio; 1 to Waterbury Castings Company, Waterbury, Conn.

Hooker Steam Pumps for every variety of pump service are shown in a 100-page catalogue just received from the Hooker Steam Pump Co., 218 Granite Building, St. Louis, Mo. Special attention is called to their outside packed plunger pump, which they make in several patterns for high duty boiler feeding and heavy pressure mine service. This pump, it is claimed, combines great strength and durability with extreme simplicity. Ample room is provided for cleaning out under suction valves. The water chambers are accessible from an opening at the side. The steam valve movement has few parts and is very simple. A copy of the Hooker catalogue will be mailed to anyone contemplating the purchase of a new pump for any service.

A handsome three-colored half-tone picture of "Watt Watching the Kettle Steam" is shown on the front cover of a new catalogue just issued by the Kitts Mfg. Co., Oswego, N. Y. On the inside is an excellent half-tone portrait of "dad" Kitts and the body of the catalogue contains a comprehensive description of Kitts Steam Specialties, together with excellent sectional and external illustrations of each appliance, including Kitts Automatic Safety Regulator; Kitts Improved Hydraulic Damper Regulator; Reducing Valves; Water Columns; Steam Traps; A Fan Engine Regulator and other specialties. The catalogue is well compiled throughout, giving sizes, capacities and prices. Anyone interested can procure a copy from the Kitts Mfg. Co., Oswego, N. Y.

The advantages of force feed lubrication are shown in a catalogue issued by the Sterling Lubricator Co., No. 2 Frank St., Rochester, N. Y. This Lubricator is fast becoming a general favorite with engineers, because of its regularity of feed, positive action and great economy in oil. A copy of the catalogue will be sent to anyone interested.

A splendid line of Packings, Hose and all kinds of mechanical rubber goods is shown in the new catalogue issued by Osgood Sayen, 421 Arcade Building, Philadelphia, Pa. Special attention is called to "Torpedo Asbestos High Pressure Ring Packing," which is meeting with success wherever it is used in connection with either high pressures or temperatures. A sample of this packing will be mailed to anyone requiring packing for extremely hard service.

Removal Notice.—The Philadelphia Grease Mfg. Co. have moved their main offices from the Philadelphia Bourse to their new factory at 848-50 S. Swanson Street, Philadelphia, Pa. Their new factory, which is much larger than their old one, and the increased space has enabled them to install additional improved equipment for the manufacture of their products. thus enabling them to fill orders promptly in future.

De Laval Steam Turbines and De Laval Centrifugal Pumps are interestingly described and fully illustrated in a new catalogue which has just reached our desk. The De Laval Turbine has met with general success since its introduction in this country. Its field is claimed to be unlimited in its application to work formerly performed by the different types of reciprocating engines. Anyone interested in Turbines should write for a copy of this new catalogue to the De Laval Steam Turbine Co., Trenton, N. J.

A circular and price list of corrugated copper gaskets has been issued by the United States Mineral Wool Co., No. 140 Cedar Street, New York City, N. Y.

The Eureka Packing Company, No. 40 Warren Street, New York City, N. Y., will send a Eureka Bill File free to any engineer who writes them for same. This firm have distributed over a million of these files among engineers throughout the country. They are popular and very convenient for filing bills, receipts, etc., such as all engineers have to handle.

The Stillman-Carmichael Improved Automatic Damper Regulator is fully described and illustrated in a circular issued by the Stillman-Carmichael Co., 18 Pearl Street, Boston, Mass.

The Armstrong Mfg. Co., 320 Knowlton Street, Bridgeport, Conn., have issued a new catalogue showing Armstrong Stocks and Dies; Armstrong Pipe-Threading and cutting Machines; The Bard Adjustable Bushing; A Line of Vices; A Hand Pipe Cutter; several different style wrenches and other tools of special interest to engineers.

A clever little pamphlet devoted to Dixon's Graphite Brushes and containing information of importance to all users of graphite brushes, has been issued by the Jos. Dixon Crucible Co., Jersey City, N. J. A copy will be mailed to anyone interested.

The Salamander Grate Bar Co., Liberty St., corner Greenwich, New York City, N. Y., issue an interesting catalogue describing their many styles of grates for boiler furnaces, a copy of which will be of interest to any reader contemplating the purchase of a new grate.

Wanted

We want a good Salesman in every city in the United States, to handle Ideal Metallic Packing. Manufacturers' Agents and Engineers, preferred.—Ideal Metallic Packing Co., South Stillwater, Minn.

WANTED.—Engineer in every city of five thousand or more inhabitants to sell and install our Engine Stop and Signal System. For particulars, write the Union Stop and Signal Co., 103 Bedford St., Boston, Mass.

Position Wanted as assistant engineer in large power or lighting station; have had five years' experience with Corliss and slide valve engines. Am 23 years old, married and can give good reference. Address, Box 12, THE PRACTICAL ENGINEER.

GAS ENGINEER would like position. Ten years' experience on Westinghouse and Allis-Chalmers gas and steam engines. Past two years on gas exclusively. First-class references furnished. Age, 35. Box 11, care of THE PRACTICAL ENGINEER.

WANTED—Engineers, Firemen, Electricians, Machinists, etc. New 25-page pamphlet containing questions asked by Examining Boards sent free upon request. Address, GEO. A. ZELLER BOOK CO., 4467 W. Belle Place, St. Louis, Mo. Established 1870.

WANTED.—Engineers and Mechanics to make big money selling Incomparable "Dozit" Hand Soap. A 10-cent can will instantly remove more dirt and stains from the hands than four cakes of any soap made, and it will not injure the most delicate skin. Small sample free. *Byram Co.*, 225 Congress Street, Boston, Mass.

ENGINEERS—The new revised edition of the Modern Engineers Hand Book. A $2.50 Book by mail on receipt of 50 cents. Be quick. Address, W. H. Ermentrout, 514 Elm Street, Reading, Pa.

Wanted Salesmen traveling among engineers to sell the France Metallic and Fibrous Packings. Good inducements on unoccupied territory, Address
FRANCE PACKING Co., Tacony, Phila., Pa.

PATENTS WATSON E. COLEMAN
Patent Attorney, Washington, D. C.
Advice and books free. Highest references. Best services.

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Patents secured promptly and with special regard to the legal protection of the invention.
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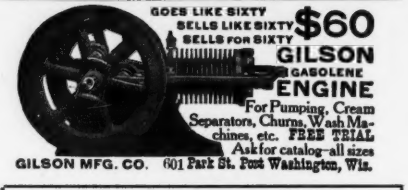
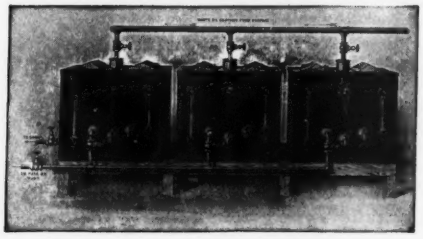


F. B. HIBBARD
MECHANICAL ENGINEER
Practical tests made of powers, plants and all troubles located; 20 years experience. Know what your power plant is doing. Coal saved equals money earned. Key. Race 4588 A.
1213 FILBERT ST., PHILA.

The Burt "Unit" Oil Filter



If you want an oil filter with large filtering capacity, yet occupying small space—one that can be used with or without an oiling system—one that can be cleaned without stopping filtration—one that will filter perfectly all kinds of oil—one in which any kind of filtering material can be used and one that has from 50 to 75 per cent. greater filtering capacity for the space occupied than any other made—you want the "Unit."

Our new 80-page catalog fully describes Burt Products.

Write for a copy.

The Burt Manufacturing Co.
204 Main St., Akron, O., U. S. A.

Improved Ventilator

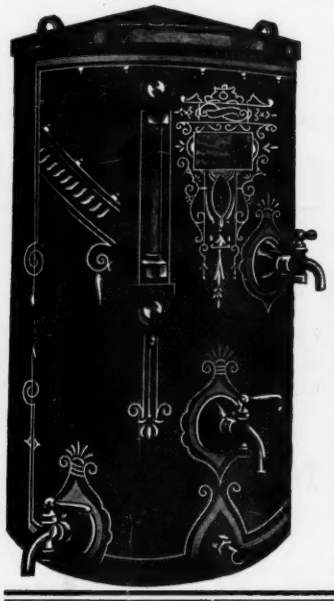
NOTICE—Sliding Sleeve Damper can be furnished with metal top if desired. (Patented).

The BURT VENTILATOR is the newest ventilator on the market—likewise the BEST. The sliding sleeve damper (an exclusive and patented feature) is easily adjusted and completely regulates ventilation. Operates without friction by means of a cord or pulley and is easily kept in the desired position without tying cord to hook or nail.

You should read our special descriptive booklet.

The Burt Manufacturing Co.
204 Main St., Akron, O., U. S. A.

Reduce Expenses



An easy, sure way to reduce expense is to utilize the service of a CROSS OIL FILTER.

The purchase of one involves but a small amount. The operating cost is about 50 cents a year and the saving it permits amounts to at least 50 per cent. of your lubricating bill.

Removes all dirt, grit and other impurities from your used oil and makes it as good as new.

Our 30-day free trial offer should interest you.

The Burt Manufacturing Co.
204 Main St., Akron, O., U. S. A.
Also supplied by Engine Builders, Dealers and Power Contractors. Agencies in nearly all the principal cities of the world.

A Noiseless Head

A characteristic feature of all BURT EXHAUST HEADS is noiselessness.

Other features make this head the most popular in use to-day. Everywhere you can see evidences of it—everywhere you will find them—BURT HEADS.

Built of extra heavy iron, lapped, riveted and soldered, they are guaranteed to last a life time.

Send for one and give it 30 days' trial free.

The Burt Manufacturing Co.
204 Main St., Akron, O., U. S. A.
Also supplied by Engine Builders, Dealers and Power Contractors. Agencies in nearly all the principal cities of the world.

The leading features of the Linton Combination Feed-Water Heater, Purifier, Oil Separator, Muffler, Return Tank and Pump Governor are described in a pamphlet just issued by the Linton Machine Co., 26 Cortlandt Street, New York City. This feed-water heater possesses many features that are worthy of mention, particularly the method of oil separation, the economical arrangement of heating surface, the efficient method of filtering, the governor which regulates either the steam for the boiler feed pump or the cold water inlet to the heater and its particular accessibility and adaptability in either the horizontal or vertical style. Twenty-eight large feed water heaters of this type are installed in New York City, ranging from 250 to 3000 horse-power capacity. Engineers interested in feed-water heaters should write for a catalogue.

Rubberbestos Sheet Packing is made of rubber and asbestos, scientifically compounded and vulcanized, with a special view to withstanding high temperatures. It is made with metal insertion for rough flanges and with wire insertion for extreme pressures. A sample of Rubberbestos can be obtained by writing A. W. Chesterton Co., 64 India St., Boston, Mass.

There has probably never been a time when mechanical stokers were in such general demand as at present. There is little doubt that the time will come when all stoking will be mechanical. Many modern plants equipped with stokers and a deal of useful information regarding stokers in general is contained in the catalogue of the Wilkinson Mfg. Co., Bridgeport, Montgomery County, Pa.

If you have any leaky gauge-cocks try a "P. H. B." Weight Gauge-Cock. They are said to be absolutely leakless and any way you can get one for free trial by writing to The Paul B. Huyette Co., 1245 Betz Bldg., Philadelphia.

It's coming time to get your cold storage insulation under way if you want to have your plant and storage rooms in efficient condition for next season. Don't put it off until it's too late and then run another season under the same old conditions. Send for John R. Livezey, 1933 Market St., Philadelphia. Mr. Livezey has made a specialty of pipe-covering and cold storage insulation for many years and although still a young man he is generally conceded to be the leading expert in his line. It was Mr. Livezey who first introduced Nonpariel Cork and proved its great value for cold storage and other insulating purposes. Write him and get your plant in condition before the ice man begins to crowd your place.

The White Star Continuous Oiling System and White Star Oil Filters are shown in a handsome large booklet issued by Pittsburg Gage and Supply Co., Pittsburg, Pa. Ask for booklet "F, 2."

Adam Cook's Sons, 313 West Street, New York, makers of Albany Grease, offer to send free to any engineer for trial a sample can of Albany Grease and an Albany grease-cup. When writing give diameter of oil hole, depth of oil hole from top of cap to journal, where it is to be used, and firm's name.

A copy of the new catalogue of the American Steam Gauge and Valve Mfg. Co., Boston, Mass., has just reached our desk, and it is well worthy of special mention. It contains 246 pages, size 6 in. x 9 in., is generously illustrated and bound in red cloth. It is devoted to a complete and comprehensive description of the company's entire line of products, including all kinds of pressure and recording gauges, valves, indicators and kindred appliances for governing, indicating, measuring, recording and controlling steam, water, air, gas, oil, ammonia and all other pressures. Engineers and others in charge of large plants requiring these instruments should apply for a copy without delay.

If you have scale in your boilers the Binghamton Boiler Compound Co., of Binghamton, N. Y., want you to send them a sample of the scale for free analysis.

Any engineer who is interested in oiling systems, oil filters, exhaust heads or ventilators and who has not yet received a copy of the handsome large catalogue issued by The Burt Mfg. Co., 204 Main St., Akron, O., should write for a copy at once.

Flexible Metal Hose is intended for use in connection with high steam pressures, in blowing boiler flues, making temporary steam connections and other severe service. A catalogue describing it and giving prices is issued by the Pennsylvania Flexible Metallic Tubing Co., 1305 Arch St., Philadelphia.

The Heath Grate Bar Co. have recently equipped the entire plant of the Great Falls Mfg. Co., of Somersworth, N. H., with their new "Reciprocating Grate." Their grate will be sent on request. Heath Grate Bar Co., No. 10 Oliver St., Boston, Mass.

A sample of Marco Diagonal Wedge Packing will be sent to any engineer who wishes to verify the interesting points brought out in the advertisement on page 79 of this issue. Address, The Cleveland Rubber Works, 74 Lisbon St., Cleveland, Ohio.

THE GANDY BELTING CO. WINS ANOTHER VICTORY.

The United States Court for the Northern District of Illinois, Eastern Division, has just issued a decree in their favor, in an action brought by them against the Weller Manufacturing Co., of Chicago, perpetually restraining them from selling, advertising, offering or announcing for sale, or supplying stitched cotton belting painted or dyed red in imitation of the Red Stitched Cotton Belting manufactured by the Gandy Belting Co., of Baltimore City, accompanied by the word "Gandy" affixed or applied thereto, or used in connection with the sale thereof.

It also permanently restrains them from in any way using the trademark of the Gandy Belting Co.

The Gandy Belting Co. announces that they were forced to bring this action in order to protect the consumer, and to break up the fraudulent practice that has grown so prevalent in recent years among certain manufacturers and dealers of selling all kinds of cheap imitation stiched cotton duck belting, claiming it to be the genuine "Gandy Belting."

Consumers are therefore warned to be particular, and see that the belting they buy bears the words "Genuine Gandy," stamped at every ten feet.

Whoever wrote the advertisement of Martin Grates, on page 60 of this issue, says, "Never mind the little things, save coal." That advice will fit many cases. Too many steam users make the mistake of chasing dollars after pennies, while neglecting the boilers and furnaces. Good grates, suited to the kind of fuel you are using, good brickwork, clean boilers and a good feed-water heater or economizer are more important from the standpoint of economy than many of the fine points of the game upon which some of us spend lots of valuable time.

A party who had recently been referred to the General Engineering Company, 764 Swanson Street, Philadelphia, called them on the 'phone and asked how long it would take them to bore out two steam valve and two exhaust valve chambers on his Corliss engine and make and fit two new steam and two new exhaust valves to the engine and have same ready for running. They told him it would not take over thirty hours.

They started on the work one morning and by the following night the work was all finished and the engine was ready for running, the actual time taken to complete the work being only twenty-seven hours. The facilities and general equipment of this company enables them to do all kinds of power-plant and machine repair work at short notice.

The United States Graphite Co., Saginaw, Mich., will send a free sample of their best writing them; also their interesting booklet, "About Graphite Lubrication."

The Boston Incandescent Lamp Co., Danvers, Mass., offer an opportunity to save money these times by using Boston Renewed Lamps, which are guaranteed to give satisfaction.

Engines, Boilers, Feed-water Heaters, Steam Separators, Traps, Valves, Lubricators, Shaking Grates and Stokers at half cost. All new. Large lot; all sizes. Quaker Eng. Co., 46 N. Twelfth Street, Philadelphia.

Now Ready!

Our New Line
OF
25c. BOOKS
FOR ENGINEERS
Nearly 60 Titles

Send at once for full descriptive Circulars
FREE

Spon & Chamberlain
Publishers of Technical Books
123 P. E. Liberty St.,
NEW YORK

EXTRA DRY

ANHYDROUS AMMONIA

Guaranteed to be free from moisture.
Contains no coloring matter such as rust or oil.

Made from Sulphate of Ammonia exclusively, therefore it is free from Hydro-Carbon Gas, the pressure of which causes high condenser pressure and in creased water consumption.

PROMPT DELIVERIES ASSURED

SEND A TRIAL ORDER

Consumers Ammonia Company

MAIN OFFICE, DREXEL BUILDING

PHILADELPHIA, PENNA.

But few concerns in the steam specialty field have enjoyed such a rapid growth as the Ohio Blower Co. Six years ago two men and an office girl started the business of The Ohio Blower Co., in a second story room on Michigan Street, Cleveland, Ohio. Inside of a year the second story was outgrown, a land lease of the present premises was acquired and a two-story building put into condition for occupancy. Within two years both floors were outgrown and an adjoining two-story building was annexed. The capacity of this building is fast approaching the limit and in the near future it will be necessary to provide larger manufacturing quarters. The principal business of these years, particularly of the past three, has been in the line of the "Swartwout" steam specialities, including cast iron exhaust heads, and steam and oil separators. The designs for this class of apparatus are all based upon the helico-centrifugal principle, under which a helix is employed to give a whirling motion to the steam, and centrifugal force is thereby enabled to separate the heavy water and oil particles from the far lighter body of steam. An extensive business has also been established in the manufacture of gravity closing ventilators.

In the second year the aggregate sales of the company increased 120 per cent. over the first year; in the third year they were nearly 200 per cent. greater than in the second, while the increase in five years has been over 800 per cent. This growth has been the direct result of extensive and systematic advertising of a product having evident merit and backed by a broad business policy. The capital stock has recently been doubled to meet the requirements of rapid increase in business. A new catalogue, very complete and attractive, is now on the press and will soon be ready for distribution. Advance requests for the same will receive attention in the order of their receipt.

In accordance with their usual custom, the H. W. Johns-Manville Co., held a convention of its branch managers, in New York, from January 29th to February 1st. The managers of the various branches of the company throughout the United States were present at the meeting and a general discussion of the business affairs of the company took place. As a fitting wind-up of the convention a banquet was given to the managers, at the Union League Club, on Friday evening, January 31st. The convention was pronounced a decided success by all present.

A sample piece of "Ebonite" black sheet packing, and an interesting booklet will be mailed to any engineer writing to the Quaker City Rubber Co., Philadelphia, Pa.

Palmetto Packing is wound on spools, making it convenient for the engineer to unwind and use as desired. Another feature about Palmetto is that you can unstrand it and use for packing small valves—it is especially recommended by the manufacturers for all valve-stems and for other service in connection with high temperatures. The manufacturers of Palmetto—Green, Tweed & Co., 109 Duane St., New York—will send to any engineer for trial, a sample spool free.

Fill out the coupon on page 82 of this issue and send it to Canfield Mfg. Co. for a sample of "Ambest" Metallic Packing.

The Cancos Mfg. Co. have an interesting catalogue, devoted to large line of packings and mechanical rubber goods which they will be glad to send to any engineer. They will also send a sample of Black Squadron Packing if requested.

A free sample can of Oxoil-Ox Belt Dressing will be sent free to any engineer or steam user who fills out the coupon on the advertisement of F. S. Walton Co., on page 56.

The rapid development of the gas engine producer plant has attracted all eyes toward the proper apparatus necessary in the installation of this type of plant. The Weber Gas Engine Co., of Kansas City, Mo., give a very interesting account of the development of the gas producer plant in which the pioneer efforts of Mr. Geo. J. Weber in experimenting with producer gas are brought out. Mr. Weber, as early as 1890, experimented with producer gas, and the Weber gas engine and Weber gas producer are the result of his many years of experience in that line. A well illustrated catalogue is waiting any engineer who writes for one.

"Test of a Small Suction Gas Producer Plant" was the name of a paper read before the Western Society of Engineers at Chicago, Ill., on February 5th, 1908, by Prof. H. B. MacFarland. Besides describing the requirements for a reliable producer, Prof. MacFarland gives a complete test which he made on the Atkinson Automatic Suction Gas Producer. The object of the test was to determine the efficiency of the installation on full load for a considerable time, to determine the fuel consumption for varying loads, to determine its adaptability to varying loads and its reliability under those conditions. The conclusions drawn were that the Atkinson producer gave an all-day efficiency of 17 per cent. under full load, 14 per cent. under three-quarter load and an efficiency of 11 per cent. under variable load. A description of the Atkinson Gas Producer and the methods of making this test can be had by addressing the Industrial Power Company, Milwaukee, Wis.

The Webster System of Steam Circulation for Heating Purposes is the name of the latest publication of Warren, Webster & Co., Camden, N. J. Like all their catalogues, it is interestingly written and well illustrated. It describes the advantages of reducing the back-pressure on a heating system and gives some very pertinent data about steam heating systems in general. The Webster oil separator, suction strainer, vacuum governor and water-seal motor which are installed in the Webster heating system are described and represent the result of the experience of equipping 4000 heating plants with steam circulating apparatus. A catalogue of the Webster Heating System will be sent to any reader upon request.

Jenkins Bros., the well-known manufacturers of valves and other steam specialties have issued a supplement to their general catalog, giving description and list prices of Jenkins Bros.' Extra Heavy and Medium Pressure Gate Valves with half-tone illustrations of each of the various types and complete data with regard to construction and sizes. A copy of this supplement will be sent to any engineer writing to Jenkins Bros., 71 John St., New York, or to their branch stores, at Boston, Chicago, Philadelphia or London.

The new catalogue "F," published by Strong, Carlisle & Hammond Co., 340 Frankford Ave., Cleveland, O., is one of the best that has come to our notice for a long while. It shows the Squires Steam Traps to excellent advantage and talks about steam traps generally in an interesting way. It also shows the Squires Boiler Feed-Water Regulator, which is in inself an interesting appliance; the Squires Pump Governor, Reducing Valves and other specialties. If any reader is interested in these specialties he should write for a copy of the catalogue.

Mr. John T. Lindstrom, 216 S. Third Street, Allentown, Pa., has a few more of his 1908 Calendars on hand, one of which he will send to any reader of THE PRACTICAL ENGINEER upon request. Mr. Lindstrom has just completed a new warehouse, built of brick and cement; a very substantial building, which gives him additional capacity for storing his Corliss valve steam traps and other specialties, and which will enable him to keep a large stock of all sizes on hand, so that he can ship immediately upon receipt of order. Mr. Lindstrom advises us that during the three years that he has been manufacturing these traps, not a single one of them has been returned to him or been complained of, but many duplicate orders have resulted.

One of the features of this trap is that in case the valve wears out, a new one can easily be substituted at trifling cost, and thus have a new trap. Mr. Lindstrom advises us that only seven new sets of valves have been purlubricating graphite for trial to any engineer chased for all of the hundreds of traps that he has sold. Don't forget to write for a calendar, and also ask for catalogue of the Lindstrom Corliss Valve Steam Traps.

SOCIETY NEWS

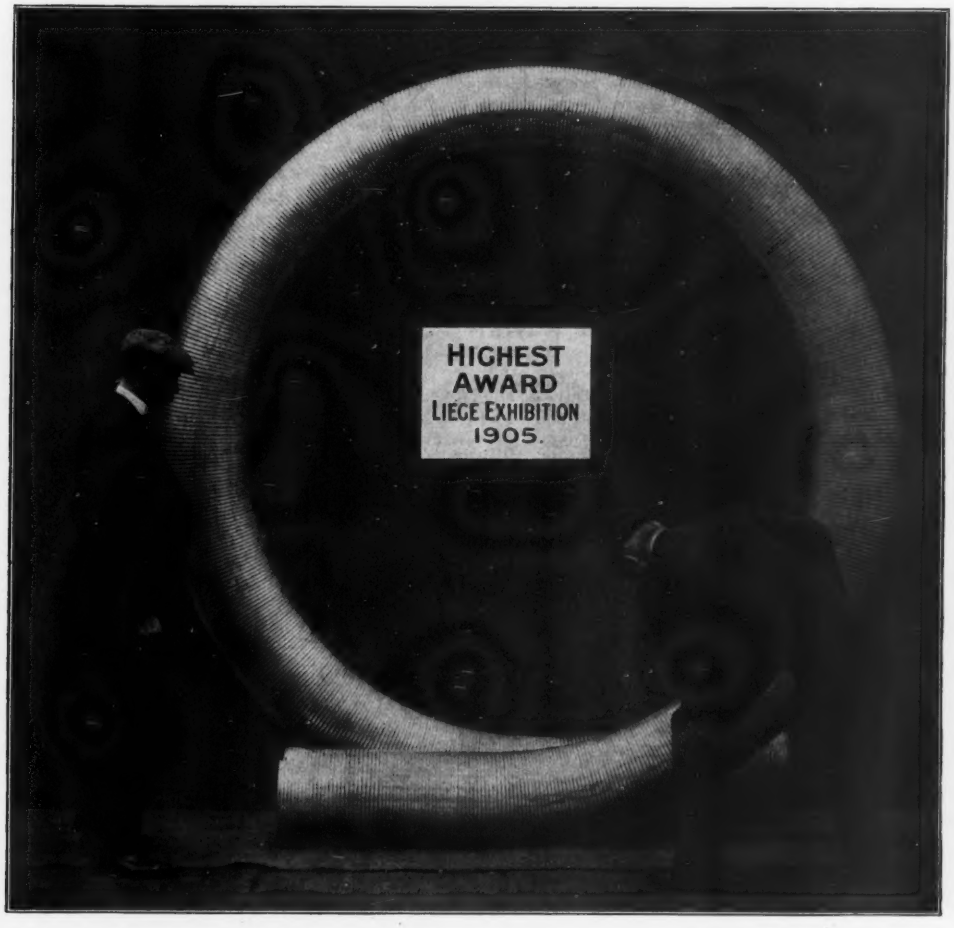
Engineers of Youngstown, Ohio, have preferred charges against W. E. Kennedy, Chief Examiner of Stationary Engineer for the State, alleging incompetency and claiming that the engineers' liscense law is not being properly enforced in Youngstown and throughout the Fifth District, of which it is a part. The complainants ask that a deputy examiner be stationed permanently at Youngstown. They also urge that the work of the department throughout the whole State be investigated. The governor has promised to go to the bottom of the matter, and, if an investigation is justified, he says it will be made. Chief Kennedy has vigorously denied the charges.

The Sixth Annual Reception and Entertainment of the combined associations of the N. A. S. E., Manhattan and the Bronx, was held in Lexington Opera House of February 19th, and, as usual, was a complete success.

The Combined Association of the N. A. S. E. of Manhattan and Bronx, are composed of the ten associations which were brought together through the efforts of Mr. Chas. W. Martin, Jr., Royal D. Tomlinson and several other members of the National Association of Stationary Engineers in the year 1903 for the purpose of conducting tests on plants operated by association members, to hold lectures, debates, and have an annual re-union in order to celebrate the work done for the year. The committee are in possession of a complete set of testing instruments and through the tests gain a great deal of knowledge and experience regarding the successful operation of our modern steam and electric plants.

METAL HOSE

For all work where high pressure, rough service and durability are required



For STEAM, OIL, AIR, WATER, GAS, Etc.

Made in all Sizes from 1-8 to 12 Inches

Flexible Metal Hose has been put to the test and has proven its superiority over rubber hose. It is being used by advanced engineers for high pressure steam and suction work. Metal hose made with INTERLOCKING JOINT is absolutely safe, and is always steam tight. Ask for "Interlocking Joint." Prices and description shown in our new booklet.

Pennsylvania Flexible Metallic Tubing Company

1305 Arch Street, - - - PHILADELPHIA, PENNA.

CHICAGO

NEW YORK—86 WARREN ST. 255 La SALLE STREET BOSTON—71 HIGH ST.

At a meeting of Local Union, No. 16, I. U. S. E., of Boston, on January 31, it was voted that no steam fitter could do work for a union engineer unless he carries a union card.

Mr. A. W. Jones, eastern representative of the American Boiler Economy Co., delivered an interesting address before Lynn Association, No. 15, Welnesday evening, January 22d.

Minneapolis Lodge, No. 2, and St. Paul Lodge, No. 7, of the N. A. S. E., held a joint open meeting on January 25th. The feature of the meeting was an address by A. M. Levine, of the Minneapolis Steel & Machinery Co., on "Gas Producers and Gas Engines."

At the regular meeting of Massasoit Association, N. A. S. E., of Springfield, Mass., on February 18th, Roscoe Allen lectured on hydraulics. William Pratt gave a short talk on draft, explaining the cause and methods of measuring it. There was a general discussion of valve setting on Corliss engines with two eccentrics. A. C. Thompson drew sectional views of siphon and barometric condensers and described the operations of each. The advisability of buying a small Corliss engine for the members to get the practical knowledge of setting the valves was considered. A committee was appointed to look into the matter. Altogether the meeting was well up to the standard of this lively and progressive association.

RECENT BOILER EXPLOSIONS AND POWER PLANT ACCIDENTS

The electric light plant owned by A. C. Hope & Sons, at Carterville, Ill., was recently destroyed by fire.

A boiler in the cement works at Longue Pointe, Quebec, Can., exploded January 29th, seriously injuring one man.

The power house of the Mobile & Ohio Railroad, at Henderson, Tenn., was destroyed by fire February 12th. Loss, $1,500.

On February 4th a boiler in the gas plant of the Public Service Corporation, Newark, N. J., exploded, fatally scalding one man.

A boiler in a public school at Adian, Mo., exploded February 14, injuring many of the pupils. The cause of the explosion is unknown.

By the explosion of a boiler at the Sheppton Colliery, of Coxe Bros. & Co., near Allentown, Pa., February 17th, the boiler room was demolished and two men were seriously scalded.

As the result of the exploding of a boiler in a saw mill, owned by E. R. Waters, at Gillam, La., January 25th, two men were killed, one fatally injured and the entire mill wrecked.

A run away engine in the sheet bar mill of the Youngstown Sheet & Tube Company's plant, Youngstown, Ohio, burst its fly-wheel on February 10th, causing damages to the extent of $15,000.

Seven men were killed by the explosion of a boiler February 3d in the rolling mill of Van Allen & Co., Sunbury, Pa. The whole building in which the boilers were located was wrecked. Loss, $75,000.

By the explosion of a boiler at Riverton, Wyo., February 4th, the entire machinery of the Van Horn Co., which had been drilling for coal, was destroyed. The boiler was used for supplying steam to the engine operating the drill.

Two men were fatally injured by the explosion of a boiler February 11th at the ice plant of Solomon & Co., Island Park, near Troy, N. Y. The boiler was attached to a small engine used in hoisting the ice from the river into the ice house.

The cylinder head of a 400 horse-power engine at the Monticello Cotton Mills, Monticello, Ark., blew out February 8th, entirely wrecking the engine and causing damages to the extent of $1,000. It is claimed that the accident was caused by the breaking of the connecting rod, which was defective.

Three men were killed and five others seriously injured as the result of a boiler explosion February 2d, at the Welsh Brick Plant, Monocacy, Pa. Frozen pipes, suddenly thawing out and permitting cold water to flow into a heated boiler, caused the explosion.

NEW POWER PLANTS AND IMPROVEMENTS

The Marietta Mantel Company, of Marietta, Ohio, will build a new steam power-plant.

The question of establishing an electric light plant in Opolis, Kan., is under consideration.

The citizens of Loyal, Wis., have voted to issue $17,000 in bonds for an electric light and water works.

A power-house will be built for the new State capitol, at Frankfort, Ky. Architect, Frank M. Andrews.

The citizens of Waynesboro, Miss., have voted to issue $12,000 in bonds, for the construction of an electric light plant.

A company is being organized in Guntersville, Ala., to build an electric light plant. V. V. More is interested in the project.

The Bowling Green Railway Company, of Bowling Green, Ky., is constructing a new power station. H. D. Fitch is manager.

A municipal electric light plant and waterworks will be built at Herington, Kan. C. H. Randall, chairman, Water and Light Commission.

A movement is on foot in Yoakum, Texas, to erect another electric light plant in the city. It is proposed to install one of the best, up-to-date plants obtainable.

The Commonwealth-Edison Company, of Chicago, Ill., is contemplating the construction of a three-story power-house, at 2438 Twenty-fifth Street, at a cost of $100,000.

The Des Moines City Railway Company, Des Moines, Ia., contemplates enlarging its power-house and adding 1,500 horse-power. The improvements will be made this spring.

The Louisville Lighting Company, Louisville, Ky., is contemplating extensive improvements to its plant, the cost of which is estimated at $1,500,000. F. M. Sackett is president.

Brandywine Summit, Delaware, has been selected as the site for the power-house of the West Chester and Wilmington Railway Company, and work will be started on the line.

The Dayton Lighting Company, of Dayton, Ohio, has recently entered into a contract with the Dayton Street Railway Company to furnish power for that line for a term of 10 years.

The City Council of Lafayette, Ind., has passed an ordinance providing for the submission to the voters of a proposition to erect a municipal light plant, advocated by Mayor Durgan.

The Harlowton Light and Water Company, of Harlowton, Mont., recently incorporated, will build a water and light system at a cost of $50,000. L. D. Glenn is secretary of the company.

The Clarendon Water, Light and Power Company, Clarendon, Texas, is contemplating improvements to its plant, the cost of which is estimated at $10,000. T. S. Kemp is local manager.

The plant of the Watauga Electric Company, of Johnson City, Tenn., is being remodeled. The line shafting and other old machinery is being removed, and a dynamo is being installed. A. Smith is president.

The Denver Gas and Electric Company, of Denver, Col., is contemplating making improvements and extensions to its plant, the cost of which is estimated at $50,000. F. W. Frueaff is vice-president of the company.

Plans for the erection of a large power-plant at Devil's Gate, in Weber Canyon, near Ogden, Utah, have recently been completed. The plant will cost $350,000 and will be built by the Utah Light and Railway Company.

The Concord Electric Company, of Concord, N. H., is contemplating the construction of a steam plant to be used as an auxiliary to the Sewall's Falls power-plant. It is expected to have the plant installed and ready for operations by next fall.

The Town Council of Lecompte, La., has completed plans for the electric light plant, and is now advertising for bids for the construction of the plant, which is to cost $10,000, according to the plans and specifications on file in the mayor's office.

The Lunkenheimer Company, of Fairmount, Cincinnati, Ohio, will build a power-plant which will double its present boiler capacity. The new plant will be erected at the northwest corner of Beekman and Tremont Streets, and will be 50 by 81 feet.

H. V. Gates, of Hillsboro, Oregon, president of the Prineville Light and Power Company, has announced the construction of a large power-plant at Lava Falls, on the Deschutes, six miles south of Bend. Operations on the plant, which is to cost $150,000, will begin in the spring.